The SCIENCE COUNSELOR

A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

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The Science Counselor

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The New Year . . .

This is an appropriate time for restating the aims of this journal, since with the present issue we begin our second year.

THE SCIENCE COUNSELOR was established with the wholly altruistic aim of improving the teaching of science in the Catholic high schools. It has no other purpose. It hopes to counsel, encourage, inspire, and help teachers of science. It plans to study with them their everyday problems of the classroom and laboratory—textbooks, apparatus, supplies,—even the time element, the importance of which directors sometimes fail to understand or appreciate. It desires to encourage more purposeful and more alert classroom teaching, more effective demonstrations, and better directed laboratory instruction.

THE SCIENCE COUNSELOR hopes to enlarge the scientific horizons of our teachers, to give breadth to their background, to widen their interests, and in these ways to assist in breaking down the artificial barriers that have been erected between the sciences. It is for these reasons that we present "fact" articles that are intended to help keep the teacher up to date scientifically, and to bring to his attention processes and procedures with which he may not be familiar.

Teaching methods as well as teaching material must be modern. Some of the papers we publish are designed to stimulate the teacher to study and analyze and improve his own methods. They tell him what other teachers are doing and encourage him to experiment in his own classroom. They may inspire him to write for publication.

We have undertaken a big job. We shall be pleased if we succeed in accomplishing even a small part of it this year. We need your cooperation.

With the Editor . . .

THE TEXTBOOK PROBLEM

What about textbooks in the Catholic high schools?

Is there a textbook problem?

Or is the situation generally satisfactory so far as the adequacy of supply, the manner of selecting, and the up-to-dateness of the books are concerned, both actually as a matter of fact, and relatively by comparison with the public high schools?

It would not be surprising if the Catholic schools with their limited financial resources were found to suffer when they are compared in this respect with the public schools which are so generously supported by taxation.

Do they suffer?

The question is serious and important. Lack of suitable books can make the learning process very difficult for both teacher and pupil. If the Catholic high schools are struggling under the handicap of a scarcity of books or if they are using poorly selected and out-of-date texts, it is important that those who are responsible for the schools should know it, so that the situation can be remedied.

What is the truth? Opinions, usually based on a more or less limited knowledge of a local situation are freely expressed; but facts concerning the book problem in our high schools in general have not been readily available. In an attempt to get a true picture of the situation as it now exists, THE SCIENCE COUNSELOR has recently conducted a survey of a number of schools located in the most populous section of the country. The results of the study are embodied in this report.

Our inquiry was concerned particularly with books in the science field, since science books become out-of-date more quickly than others. The schools studied are located in the territory that extends roughly from New England to Minnesota to Illinois, Kentucky and the District of Columbia. At the request of Rev. Paul E. Campbell, Superintendent of Parish Schools of the Diocese of Pittsburgh, the diocesan superintendents of schools of some twenty dioceses in this area supplied valuable information about the schools under their direction. The more important textbook publishers who furnish science textbooks to the Catholic schools and their special representatives who are assigned to the Catholic field, cooperated in the survey by giving information and opinions on matters in which they should be especially well informed. It was expected that their point of view would be somewhat different from that of others who were consulted. Teachers in the field were a third source of information. Some were reached through correspondence and others by personal contact. The number of teachers who were concerned actively in the study was not large nor were they widely distributed geographically. With the understanding, of course, that the replies to our enquiries were to be held in confidence and that in our report no identifiable reference would be made, information both favorable and unfavorable was given very frankly by those who were consulted.

What does the survey reveal? What is the situation?

Generalization is difficult because of the many variables concerned, but it is fair to state that, considering present economic conditions, the results are not too alarming. Neither are they entirely pleasing. There are places where the situation can be and should be improved. There are ways and means of doing it. We do not agree with the correspondent who feels that each parish is wholly competent to deal with its own problems. Cooperation among the schools is desirable and, for the good of all, almost essential. There are parish schools which need more science books and better science books and more modern science books. But, as one publisher's representative states: "For every Catholic high school that is possibly not so well equipped with textbooks as it should be, I can point out a corresponding public high school in the same condition."

Other publishers declare that the book situation in the Catholic schools is not as good as in the public schools of the same territory. A number of diocesan superintendents of schools, especially in the northern and western districts, are satisfied that the textbook problem in their own schools has not been solved; while two superintendents in other dioceses say that it is questionable if their present methods for obtaining books are satisfactory. About half the superintendents consulted believe that their schools now have an adequate supply of modern texts and that there is no need to change the method of selecting books or of providing for their purchase. It is apparent, however, that the Catholic schools in general do have a book problem, and that something should be done about it.

There is at present in wide-spread use no systematic method of selecting textbooks, no completely satisfactory method of financing book purchases, and no adequate provision for insuring the discarding of out-of-date texts. Perhaps these things never can be. Probably they will not be, but, certainly, improvement in all these respects is possible. Even if it were desirable, uniformity probably could not be achieved because of the dissimilarity in the control of the schools. Some are privately owned and operated by religious communities; some are strictly parochial; others are diocesan central schools. Such diversity in direction results in differences in thought, organization, financial systems, methods and procedures. So far as the textbook problem is concerned it means great variation in the mode of selection, purchase and change of books.

Who decides which textbook to use?

One-third of the dioceses reporting state that the principal of the school makes the selection. In one-fourth of the dioceses the principal and the teacher in charge of the course together choose the text. Various other procedures are followed. In a few districts the teacher alone selects the text. In one diocese the principal and the pastor collaborate. In certain large high schools the work of selection is entrusted to the head of the department concerned. A publisher observes: "More and more the individual teacher's recommendation prevails with the higher authority." A second publisher states:

> "Books are sometimes selected by school administrators rather than by teachers. There are obvious weaknesses in that plan. Perhaps an ideal arrangement would be collaboration between a teacher and an administrator or supervisor. The supervisor would be likely to keep the interests of the student uppermost in his mind, which would offset a tendency that we sometimes observe for a teacher to select a book that is easy to teach from rather than one that is easy to learn from."

Do all these varied plans for selecting books operate satisfactorily? Probably not. Some superintendents declare they are not wholly satisfied. One publisher believes too little care is taken in choosing textbooks. He says: "In my experience there is too little actual comparison of textbooks. To me this is the only honest way of discovering any superior merit in a text. Topic for topic should be compared as to up-to-dateness, simplicity, etc. Too many are content to depend upon the verdict of others."

Another publisher suggests that some of the defects in our textbook situation are the result of a form of carelessness. He writes:

> "Many teachers who otherwise take their work seriously avoid as far as possible any change in textbooks. Sometimes this may be due to the teacher's familiarity with the book he is using, but more often I suspect it is due to his failure to familiarize himself systematically with newer books. The criticism is as true of the public schools as it is of the private schools, possibly more so."

There is one way at least in which the Catholic situation in many districts can be bettered almost immediately without expense. Science textbooks, of all books, should be selected objectively, in a scientific manner. An excellent plan, and one that in time will become more widely used when its benefits are appreciated, is the diocesan adoption of books. But the work of selection must be properly done. The books chosen should receive approval only after a very careful study of all the available texts of a similar character. A textbook committee, composed of teachers in service who are now actually teaching the subject, should work under the direction of the diocesan superintendent of schools.

The committee should be a standing committee. Its work has not been completed when a list of books has been approved. Textbooks, especially in science, must be kept up-to-date. Someone in authority must decide when to discard books because they are antiquated. Recency of publication is not always a criterion.

There can be no set time at which science books should be changed. "Possibly every five years unless the book has been revised," one publisher suggests, but he believes that this may not hold true in the case of textbooks in general science, which may not require such frequent changing. Another publisher makes the point that it is not good practice to continue using a book "when succeeding classes have become, by devious methods, too well acquainted with the work of preceding classmates." A third publisher makes constructive suggestions when he says:

> "It seems to me that a teacher should be expected to keep informed about new books as they appear, and to consider that as much a part of his job as actual classroom teaching. Possibly at the end of each school year it would be well if the teachers of any particular school system could devote some time and discussion to the matter of possible changes. If this were done it would be possible to evaluate new books, determine their comparative value as against books in use, and then make changes on that basis. Unless there are improved materials available, it hardly seems reasonable to make a change merely for the sake of the change itself.
>
> "Publishers often feel inclined to criticize the methods of selecting new books on the grounds that selections are not objectively made. In some instances a score card seems to aid in securing objectivity, but score cards doubtless need to be used with a great deal of judgment. One thing on which I do feel strongly is the matter of seeing all the available books. A teacher, by a more or less accidental process, sees a book which he likes and secures a change in the adoption on that basis. I feel that when a change has been determined upon, it would be better if the teacher communicated with all of the textbook houses and asked for their offerings in that subject. Most, if not all, of the publishers are generous with samples providing the samples are asked for in good faith. An examination of all the books in the field should certainly increase the likelihood of a sound selection."

Who pays, and who should pay for the books? The student? The school? The state?

The most common practice is for the pupil to provide his own books. The practice has both advantages and disadvantages. In many, but not all of the schools in five dioceses located in the northern and eastern part of the area surveyed, "free" books are provided, that it, books that are lent by the school to the student without charge. In six scattered dioceses a rental plan is in operation. In the other districts the student pays for his own books, although it is a universal practice for schools to furnish books free to pupils who are too poor to pay for them.

Every diocese which now furnishes free textbooks reports that the system is working satisfactorily. Some dioceses which have adopted the plan might not have done so under other conditions. One superintendent remarks: "Since the public high schools in our state furnish all textbooks without charge, the parishes are

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The Glacier Priest

• By Reverend Edward Shipsey, S.J.
HEAD, DEPARTMENT OF ENGLISH, SANTA CLARA UNIVERSITY

A member of the Society of Jesus, an explorer of out of the way places, a scientist engaged in geological research, teacher, lecturer, and author —this is Father Hubbard, the "Glacier Priest."

The life story of this priest of world wide fame will be most interesting to our readers, many of whom have heard Father Hubbard tell of his experiences in Alaska.

●

Rev. Bernard Rosecrans Hubbard, S.J., was born in San Francisco, November 24, 1888, the son of George Milton Hubbard and Catherine Cornelia Wilder.

His father was of French and New England (Maine) stock and his mother of New York Knickerbocker stock, being a first cousin of Washington Irving.

His father who was a graduate of Trinity College, New York, was an Episcopalian clergyman for some years. About the time of Father Hubbard's birth, he and Mrs. Hubbard became Catholics. Thereafter, for a time, he was on the faculty of St. Ignatius College, (now the University of San Francisco) and, later, on the staff of the Hibernia Bank, San Francisco.

Father Hubbard has a brother, Captain John D. Hubbard, mining and civil engineer of Chico, California; and a sister, Mrs. E. J. Stanley, Santa Clara, California.

His middle name was given him by his parents out of regard for their friends, Gen. and Mrs. W. S. Rosecrans (Civil War leader).

Up to the age of ten, the future explorer and scientist was unusually frail and delicate. His father then bought a farm property out of Boulder Creek, on Ben Lomand, in the Big Basin redwood area of the Santa Cruz Mountains, about fifty miles south of San Francisco. Here with dog and gun and camera, the boy spent his weekends and his vacations, exploring woods and mountains, climbing the treacherous ocean cliffs near Davenport and developing that habit of acute observation which has become second nature to him. Here he acquired a robust constitution, a taste for life in the open and the nickname Fossil Hubbard, on account of the odd things he'd bring to school on Monday mornings.

By 1908, at the age of twenty, he had completed his high school course at St. Ignatius High School, San Francisco and two years of college at Santa Clara College; he had achieved facility in written and oral expression, had laid the foundation of the sciences basic to geology and had expanded his boyish taste for examination on the spot itself of those geological features which most interest him, the study of formations and of physical geology. The Yosemite Valley and the Grand Canyon of the Colorado had been studied and photographed and a trip to visit relatives in New York, New England and Eastern Canada had contributed opportunities for observation.

In 1908 he entered the Society of Jesus at Los Gatos, California and began that long course of professional and scientific studies which is implied by membership in that order. His studies at Los Gatos were chiefly of a religious and literary nature, but not without opportunities to push his field expeditions in the vicinity. For five years thereafter (1913-1918) he was an instructor in scientific and literary subjects in Loyola High School in Los Angeles. Again he used his leisure and holiday hours and days to increase his knowledge of the neighborhood in which he lived.

His presence at St. Michael's College, Gonzaga University, Spokane, Washington, (1918-1921) was more to his taste in this regard. Here he found himself while doing advanced work in philosophy and the sciences, in the midst of one of the most remarkable areas in the world for the study of the aftermath of great

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Father Bernard Rosecrans Hubbard, S.J.

The Cultural Value of Science

• By Sister Mary Claver, O.S.F.
MOUNT ALVERNIA HIGH SCHOOL, MILLVALE, PA.

Has science cultural values?

What is culture?

Does the inclusion of the several sciences in our high school curriculum stimulate in our pupils a vigorous mental growth? Does it encourage straightforwardness in thinking? Will it give a clearer view of life and its problems?

Sister Mary Claver's thoughtful article discusses these questions.

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In this age of materialism when each subject taught is measured by its bread-and-butter value, the true purpose of teaching science in the high school is often disregarded.

Science is not taught primarily for the purpose of constructing radios, of understanding the mechanics of an automobile, of improving roads and canals, but for the purpose of improving the individual. Both the individual and society would be at a great loss if the physical products of science were destroyed, but this loss would be almost insignificant so long as the spirit and ideals of science remained. If, however, this scientific spirit should disappear, nothing less than the loss of civilization would result.

The gradual lowering of the real ideals of science is helping to cause a decline in our present civilization, and unless something is done to revive the true spirit of science, our civilization will meet the fate of earlier civilizations. Since it is the student of today that is to carry on our civilization, it rests with the present-day science teacher to inculcate genuine scientific spirit and ideals. This he cannot do, unless he himself has imbibed this spirit and unless he realizes the fact that science has more than practical and pecuniary value. The student must, therefore, be made to understand that science is not entirely devoid of cultural value as the devotees of a purely classical education would have him believe.

The term science is here used to include those sciences usually taught in the high school, namely, general science, biology, chemistry and physics.

But does science really have cultural value? In order that this question may be answered intelligently, the word "cultural" must be understood. Confrey defines culture in education as the detachment of the heart from the gross pleasures of the senses, and the appreciation of material, intellectual and aesthetic excellence, together with a love of moral and spiritual perfection. Therefore, any study that assists in developing this detachment and appreciation may be called cultural. This science does in its own peculiar manner. The cultural value of science lies in the fact that science aids one to attain a vigorous mental life as well as a clear view of things and their relation to men. It assists in prompting that straightforwardness in thinking that makes the world a place of law and order.

But how does the study of science enable the student to attain this mental life, this clear view of things, this straightforwardness in thinking?

The very first thing science does for the student is to increase his power of observation by bringing him face to face with the hundred and one common phenomena of everyday life. His environment takes on an entirely new aspect and he is no longer satisfied with the mere sight of the manifestations of nature. He traces every incident of his surroundings to its last cause, and finds delight in his discoveries. Nothing in nature is too simple to arouse his interest and aesthetic appreciation, and even the things unpleasant to the senses have for him a hidden excellence unknown to the average individual. This initiative in observing the occurrences about him, takes the mind of the student from himself. It increases his interest and deepens his sympathy not only for the things around him but also for the persons with whom he comes in contact. He soon imbibes that unselfish spirit, characteristic of all great scientists, which thinks nothing of personal gain but only of the good of humanity.

There is a considerable feeling of satisfaction and a certain amount of pleasure in overcoming an obstacle. Science presents to the student problems to be solved, experiments to be performed and theories to be mastered, all of which contain seemingly insurmountable difficulties, which, when overcome, give the student a happy feeling of conquest. These experiences of meeting and overcoming difficulties help to stimulate will-power so that when other obstacles are met, they will, because of past experiences, be faced with a feeling of confidence and fought perseveringly until conquered.

The admirable traits of stability and exactitude shown in every experiment, definition and law in science give to the student a certain precision in acting and thinking not otherwise acquired. There can be nothing inaccurate and slipshod about science. Each experiment performed must be done with real thoroughness, each definition formulated must be worded with exactness, and each law stated must be expressed with correctness. The student, thus, is furnished with ideals of accuracy and honesty helpful not only in science but in everything he does.

The training value of science in its direct bearing on the highest intellectual faculties is found in the facility

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Science in the Vegetable Garden

• **By G. J. Raleigh, Ph.D.,** *(University of Chicago)*
DEPARTMENT OF VEGETABLE CROPS, CORNELL UNIVERSITY

Everyone likes to watch things grow, but not every amateur gardener can make them do it. Sometimes the reason for failure is a very simple one.

In high school, students can acquire valuable information about soils and soil reactions, fertilizers, plant pests, pollination, the need for diversification and other interesting gardening matters. To the wide-awake teacher this article will suggest ways of using a vegetable garden as a botanical laboratory.

The vegetable garden is a good laboratory for the study of plant science. In addition it offers an opportunity to earn as well as learn—at least to cut down the family's budget for food. Not only does the vegetable garden offer a fine place to watch plants grow and to experiment, but it also gives a better understanding of the job of the horticulturist. Many of our people in the larger towns look upon farming as drudgery done by those who have insufficient training to do other work. The student interested in a garden will soon learn to appreciate the fact that the progressive farmer must be a scientist—at least he must diligently apply scientific findings.

Must one necessarily have a large garden in order to enjoy it? Certainly not. It may vary in size from one that contains only a few square feet where a couple of rows of lettuce might be planted, to one an eighth of an acre in size which should supply most of the vegetables required by an average-sized family for a large part of the year.

If possible, the garden should be located near the home where it is convenient to see it often and to gather the vegetables without loss of time. Many vegetables grow so fast that the garden looks very different after a week of vacation. And, of course, weeds grow faster than the vegetables. In case good soil is not available in the back yard it will be advisable to seek it elsewhere. A sandy loam soil is best. Vegetables do not like wet feet. Moreover a soil that drains well, as does a deep sandy loam, warms up quickly in the spring and makes early season crops possible. On a soil of this type warm season crops such as melons and egg-plants can be grown satisfactorily in latitudes where it would not be possible to produce them on heavy soil types. Avoid areas that are shaded.

Probably more vegetable gardens fail because of unfavorable soil reaction than as a result of any other single cause. Many of our vegetables will not thrive in a soil that is too acid. For example, asparagus, beets, celery, leeks, lettuce, onions, parsnips, salsify and spinach do best in a soil that ranges in reaction from *p*H 6.0 to *p*H 6.8. No one should plant a garden unless he knows that the soil reaction is favorable, and it is not possible to tell this fact without testing the soil for acidity. If the test indicates that the soil is too acid, ground limestone or hydrated lime should be used to bring the soil to the desired range of reaction. One might ask why not add some lime each year. Many do, and as a result the soils in many of the home gardens in some sections of the country are alkaline—a condition unfavorable for the growth of most vegetables. It is a greater error to make the soil too sweet by the use of excessive quantities of lime than it is to allow it to become too acid. There is no satisfactory cheap way of quickly making alkaline soils more acid. Many county agricultural agents are equipped to test soils and to make suggestions concerning the lime requirements of various vegetables.

Studying a seed catalogue is good sport for any one interested in gardening. Many of the newer varieties of vegetables have resulted from intensive work on the part of the plant breeder, using many of the fundamental laws which Mendel found while he was following a student's yearning for knowledge by experimenting with garden peas. Choose varieties that are adapted to your section and soil, and make plantings so as to have a succession of crops throughout the season. Nothing marks the uninformed gardener more clearly than an over-abundance of vegetables during mid-summer and a lack of variety at other times during the growing season. Your state college of agriculture will supply you with planting plans and lists of suggested varieties.

While studying varieties and plans, consider some of the fundamentals that relate to pollination. A single row of sweet corn or adjacent rows of corn that shed pollen at different times will not produce satisfactory ears. The wind will carry the pollen that falls from the tassels away from the silks and a poor job of pollination will result. Many vegetables (usually cases of those in the same species) will cross pollinate, and if you save seed from plants that have been cross pollinated you are likely to be surprised by the mixture produced from such seed. Appearances are sometimes deceiving—for example pumpkins will cross with straight neck squashes. On the other hand melons will not cross with cucumbers in spite of the opinions of many gardeners. A poorly grown melon may be of poor flavor and one might imagine that it was produced from seed that resulted from a melon blossom being pollinated by cucumber pollen, but such a cross has not yet been recorded.

Fertilizers have been given a large share of thought

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The Problem of Supervised Study

● By Mary W. Muldoon
PRINCIPAL, JUNIOR HIGH SCHOOL, WAVERLY, N. Y.
SUMMER FACULTY, OSWEGO STATE NORMAL SCHOOL.

Here is direct and immediate help for the teacher who is puzzled because his teaching does not succeed, although his pupils are attentive and apparently working hard.

In this article an experienced teacher and administrator, well versed in the technique of supervised study, writes plainly and to the point.

Supervised study works!

●

PART I

One day during the summer of 1935 the writer's class in principles of junior high school education was combined with another instructor's group in history methods, so that she might demonstrate to both classes how to begin teaching junior high school students to use their textbooks. At their next class meeting she asked her own students for their reaction—questions or criticisms.

A man from Maine, a teachers' college graduate, looked up and said bluntly, "Do it again."

"Why? What for? What do you mean?"

"Yesterday was the first time in my life that any one ever tried to show me how to study. If I had had that lesson ten years ago, it would have made a big change in my college career. I need more of it."

Another man, a New York State teachers' college graduate this time, added, "If that lesson had been given to every class in this school the first week, some of the men would not have had to work such long hours this summer. They'd be able to get their assignments easier if they knew better how to use their texts."

There was a chorus of assent, and a general nodding of heads. An immediate census disclosed that of the mature men and women in that class—experienced teachers representing school systems in some twenty cities and two states—only one had ever had any previous direct instruction in how to study, and he had received it during "Orientation Week," in his freshman college year. The entire class seconded the request for another demonstration, and when they appeared for it the following morning some of the men were accompanied by visitors from other departments who asked permission to audit. This article is an outgrowth of that experience, plus some supplementary investigation which seems to indicate that while much is being said about teaching children to study, in too many schools very little is actually being done about it. To the experienced instructor, the methods cited may seem both old and obvious. This paper is not addressed to him but to the earnest young beginner, who is honestly puzzled because his teaching does not seem to get across, although his classes are attentive and apparently working hard.

As a matter of fact, a single instructor seldom teaches a student "How to Study." During the junior high school age at least, the ability seems to be specific and not general. One student may have no difficulty in learning his algebra lesson, while he struggles vainly to find out how to get his Latin. At the same time his sister may be just reversing his experience. Students can be taught easily how to study a map, or a history text, or the spelling of a new word, how to attack an algebra problem, to examine a specimen in biology, or to get the most out of a reference book, but no single teacher is apt to do the complete job. For a certain minimum training in different methods of reading, and the use of dictionary and encyclopedia, the home room teacher or the English department may justly be held responsible, but in the final analysis teaching how to study algebra is the job of the algebra teacher, teaching how to study Latin is the job of the Latin teacher, teaching how to study science is the job of the science teacher. No matter who carries out his plans, the teacher of every class is, or should be, held responsible for teaching the technique of study in his particular subject, and it is undeniably easier for all if each does his fair share. Of course, efficient teachers of different subjects will use their study periods differently, but all must use them toward the same end—improving the learning situation and the pupils' method of study. The basic philosophy upon which attention should be focussed is the principle that the facts acquired by any student are of little importance compared with the habits formed by that student in acquiring those facts; the answering of his questions is less important to the student than training him how to find the answers for himself.

What is supervised or directed study? The answer depends largely upon the person questioned. It is difficult to find two school systems, or even two instructors, to whom the phrase means exactly the same thing. To the writer, and throughout this article, *supervised study* means that time has been provided in the subject teacher's class room, before, during, or after the recitation hour, for the class to prepare the assignment under the eye of that subject teacher, who is responsible for showing them how to study the lesson, and also for seeing that they do it and do it in the right way. Supervised study may also mean that students are preparing their lessons in a study hall under a *working* study coach, but even here the coach is using as a basis for his procedure the questions, outlines, or other study guides handed to him by the subject teacher.

If we honestly desire to teach students how to study, *the first step is to give them a chance to study.* The habit of study must be built like any other habit, by practice plus repeated practice, and it takes much longer to do this with some students than with others.

The proportion of class time spent in directed study will, and probably should, vary from day to day, but in the long run it will remain nearly constant from week to week. The writer's experience indicates that the study periods should ordinarily take at least half of the time allotted to the major subjects in junior high classes, and probably in some sophomore classes in the senior school as well. After experimentation covering some fourteen years, one half of the time devoted to the major subjects in this junior high school is given to "recitation" periods—development of new work, experiment, demonstration, oral discussion, dramatization, brief oral or written fact tests, speed drills, board work on power questions, and the like—and the other half to supervised study, with the subject teacher alertly observing study methods, quietly correcting wrong ones, and giving a minimum of assistance to students in difficulties. Except in case of absentees, if much individual instruction is needed *on the day's lesson* one of two things is usually true, the student is out of his proper grade, or the assignment has been faulty.

Before asking pupils to study, the wise teacher will make sure that surrounding conditions are right, or at least as nearly right as possible. As the science teacher "sets up lab" before he goes home at night, the supervised study teacher must make sure that ink wells are filled, crayon is ready, books, reference material, specimens, and other supplies are at hand. Continual supervision of lighting, adjustment of window shades, ventilation, temperature, and relation of seat to size of pupil is the study teacher's business, though student committees can be a great deal of assistance in managing these items, all of which have an important, even if unconscious, effect upon pupil attitude. Students at work should be watched for symptoms of eye strain, defects of hearing, and spinal curvature; posture defects should receive individual attention as the term goes on.

The pupil also must be trained to have his material on hand and ready. Unless free texts are furnished, every student should be required to provide his own individual dictionary, the bigger the better, though one from the ten cent counter is better than none at all. He must also have a pen, several pencils, a ruler, a blotter, and an eraser, and be taught to carry these with him to every class, and to sharpen his pencils outside class hours. "Every workman worth his salt has his own tool kit, and his tools are ready and in working order when he comes on the job."

Granted a comfortable environment, the next step in teaching to study is to make clear how the trick is done. Teaching to study is like teaching to swim, we explain the theory, and then make the learner go through the motions, sometimes for a long time without perceptible effect, until all at once he "gets the knack," and most of the bother is over. Since reading is one of the most important means to study in the secondary school, the first thing we teach our seventh grade Junior High students is how to get information from their textbooks.

The writer's experience leads to the belief that there are at least three separate training levels in teaching students to use textbooks easily and efficiently. The first is getting the ability to find in any particular paragraph the correct answer to a definite question. The second is being able to locate in the text the important items—the items to be learned—by the use of a furnished outline. The third level, *which some students are never able to reach*, is having the student make his own outline. A great deal of our later difficulty in the study period comes from expecting students on the first level to do work on the second or third.

Suppose we start with an average class of entering seventh graders. Using any class text, we locate the author's name, the publisher's name, the date and holder of the copyright; find the table of contents and the index, and explain clearly the use of each. Then we point out the chapter headings and the heavy-type paragraph topics, and show how we can use these to make one kind of "skimming" easy. (Another kind is taken up later.) This is followed by speed practice in the use of the index, kept up until the majority of the class can locate a new topic anywhere in the text in from 30 to 40 seconds. This preliminary instruction is a definite requirement of the first quarter of the seventh grade, but due to the influx of new rural students each year, it is reviewed briefly at the beginning of the eighth and the ninth grades as well. Until it is finished no assignments are made in the text for outside study, but now we give a brief one, the ensuing study period going something like this:

"Turn to the assignment and read the first paragraph as rapidly as you can."

(The sample paragraph is taken from Smallwood and others' *New General Biology*, and is presented because it was actually used to begin the work with one "slow progress" class of ninth graders last fall.)

SOIL

"The coarsest kind is gravel, composed of small, usually round stones. This is the poorest kind for most plants as it does not hold water well. Somewhat better in the matter of holding water is sand. Irrigation has made thousands of acres of sandy land productive, as water can be supplied whereever it is needed. Loam is fine sand, mixed with a large quantity of decayed organic matter known as humus. This is one of the best kinds of soil for retaining water. Clay is very fine hard-packed soil, which retains water well, if it is allowed to soak in. Muck consists almost wholly of decayed organic matter."

As soon as the closely observant teacher sees that two or three have finished reading she says, "Time." Then, "Name the coarsest kind of soil, Tom."

"Gravel."

"Of what is gravel composed, Jean?"

"I don't know."

"Look at the paragraph again. Read it until you find out."

"Small round stones."

"Why is gravel not good for growing plants, Mary?"

"It doesn't hold water well."

"What is mixed with sand to make loam, Tom?"

"Humus."

"What is humus, Mark?" And so on, until every obviously important item of fact has been covered in order with the students' books open. There is no fussing about standing to recite nor answering in complete statements—these children are not "reciting"; they are *working*, and we concentrate on that work.

Next, with books still open, we see if the class can recognize the same facts when we rephrase the questions:

"Name four important grades of soil, William."

"Name in order of their ability to retain water, Frank."

"Name the grades in order of fineness of texture, Alice."

In each case we meet failure or error with the direction, "Read your paragraph again," until the right answer is given. Finally we put *to the entire class* a question which requires judgment: "Which probably will be the more fertile muck or loam, and why?" The student volunteering a recitation is required to show the reason for his answer by being asked to read aloud the phrases upon which he bases it. Then we proceed to the next paragraph, and handle it in the same fashion, take the next and the next so far as time permits. The first half of the study period will be devoted to this kind of group work, the class studying with the teacher. Then the pupils are told that the rest of the period is theirs for silent study. No notes are taken during the first reading, but they are now advised to write down the points hardest to remember, and to study these hardest things longer. The importance of going to work at once, and not stopping until the task is completed is emphasized, and the class is informed that they will be tested on this material tomorrow, and also that they will be asked to identify samples of some of the soils studied.

When these pupils report for the next class meeting, there will be no question and answer testing. The greeting to them will be, "Is there anything that you still do not understand? Are there any questions?" Those presented will be answered carefully, *by reference to their open books if possible;* if not, by the teacher's explanation. Then four students with samples of soil will be sent to the board each to identify a different one, and write out his reason for naming it as he does, while the rest of the class takes a brief "fact test."

"Number your paper from 1 to 10 as if for a spelling lesson. I will give you ten questions, each of which can be answered by one word. Write the word which answers the question after the corresponding number. Ready?"

"1. What name is given to a soil made of coarse rounded pebbles?
2. To a soil composed of fine sand mixed with humus?
3. Which of these holds water better?
4. What is mixed with sand to make loam?" etc.

At the end of the set, the teacher reads the correct answers, and the pupils mark their own papers, which are collected immediately. Next the board work is criticized by the class, and if necessary by the teacher, who finally endorses each paragraph G—F—or Unsatisfactory. *Every student has been tested*, most of them on the entire assignment, in from seven to ten minutes, and the rest of the period is free for experiment or demonstration, discussion, development of new work and directed study. This is, of course, only one of many ways in which preparation can be checked, but it is a method strongly recommended during the first few days when we are beginning to study how to use texts. The teacher by merely leafing rapidly through the test papers sees quickly whether the majority of the class is getting the assignment, finds who the weaker students are, and arranges to call upon them more frequently *in the study period*, and cuts or increases the length of the assignment as the results indicate.

The inexperienced beginner will note carefully certain fundamental points in the simple technique outlined. First, the direction, "Read as rapidly as you can," and the fact that the teacher calls "Time," as soon as two or three have finished. The first reading is merely to give a general idea of the gist of the paragraph, to get a bird's eye view, and continued stress upon rapid reading does speed up the reading rate. The pace demanded also helps to keep attention concentrated. The human animal, like every other, needs a certain amount of prodding before he learns to work, and a reasonable amount of pressure—"Read as fast as you can."—"This must be done by nine o'clock tomorrow morning"—is a rather important factor.

The second point to be noted particularly is: *The teacher must be on guard to see that he does not do the work for the pupil.* The fact questions are distributed over the class, and addressed to individual students, instead of being given to volunteers, though until the work is well started the wise instructor will call upon good students first. If the pupil questioned makes an error, or says, "I do not know," he is *not* told the answer. His direction is, "Read the paragraph again until you find out." The entire class is made to concentrate upon one definitely limited difficulty at a time. If the failing student is very slow he may be told, "Stand up so I won't forget to call on you again. The rest of us will go on while you look that up" and the teacher will return to him a minute later.

Third: the power questions, or applications involving much reasoning, at first are always given *to the class* instead of to individuals, and are answered by volunteers. *As a rule no one fails.* The class soon gets the feeling, "We can do this."

Fourth: the class is not set to work on its own initiative until it knows exactly what it is expected to study —it understands the assignment — and the students know that in some fashion everyone will be tested. Each pupil is made to feel that he has an actual job to accomplish at a definite time, and that he will be re-

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THE SPIRIT OF EDUCATION

We are glad to present to our readers this reproduction of N. C. Wyeth's splendid mural, The Spirit of Education. It was painted at the request of Silver, Burdett and Company to commemorate the fiftieth anniversary of the founding of their firm.

For fifty years Silver, Burdett and Company have been engaged in the publishing of textbooks of high character. Their books, especially in school music, in the language arts, and in geography have been powerful forces in influencing teaching in these fields. The publications of this firm now cover the whole field of matter found in modern schools from kindergarten to college, and their list of authors, past and present, contains many names noted in American education.

The interpretation of "The Spirit of Education" here presented was given in an interview by the artist.

INTERPRETATION

In the center of the picture the dense clouds of Ignorance and Prejudice have parted and to the earth has come an heroic figure symbolizing the Spirit of Education. She holds aloft the flaming torch of enlightenment, while open before her lies the Book of Learning. Mercury-like she moves forward on the winged wheel of Progress.

Representative Americans, who typify for their day and time the Spirit of Education, move in slow procession toward the figure, from the right and from the left.

The left-hand processional is that of the Pioneer Teachers—pioneer in the sense that these particular leaders ventured into new fields and broke new ground.

Leading this group is an idealized figure of the Colonial schoolmaster.

Next at the left are two Indian boys and a Franciscan priest (Junipero Serra) who symbolizes the heroic work of pioneer missionaries among the Indians, especially on the West Coast.

Directly behind them are two of the Dame school teachers who laid the foundations of our elementary public school system.

Then comes the Negro educator, Booker T. Washington, who sought equality for his people in the field of education. With him is a negro boy carrying a hoe to symbolize vocational training.

At the extreme left is a thoughtful and introspective trio; Benjamin Franklin, representing balanced judgment, Thomas Jefferson, penetrating political and educational sagacity, and Joseph Lancaster, educative originality.

In the background at the left side of the mural is the log cabin of the frontier—the land of the pioneers; and, beyond, the long sweep of open country merging

Continued on Page Twenty-three

The Analysis of Industrial Gases

● G. H. Burrell
VICE PRESIDENT, BURRELL TECHNICAL SUPPLY CO., PITTSBURGH

The analysis of gases in industry is important in a number of ways, such as the determination of the combustion efficiency and the heating values of manufactured and natural gases, the control of furnace atmospheres, and the regulation of ventilation in mines.

The theory involved in gas analysis is not difficult to understand. Practice in work of this kind, however, is usually not included in the training or experience of the high school teacher of science.

This article, written by an expert, discusses methods and procedures.

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The analysis of gases in industry is confined for the most part to so-called fuel gases and the products of their combustion. The work is of major importance over a wide field in the production of gases, the control of furnace atmospheres, the determination of combustion efficiency and heating values, and the like.

Fuel gases, principally natural and manufactured gases or mixtures of the two, and the products of combustion commonly called flue or chimney gases, vary widely in composition and may contain any or all of the following components:

Carbon Dioxide, Oxygen, Illuminants, Carbon Monoxide, Hydrogen, Methane, Ethane and Nitrogen.

Other components such as dust, water vapor, ammonia, tar vapor, etc. may be present in some mixtures but if these are determined at all, they are handled by special methods that are beyond the scope of this paper.

In natural gas, methane is usually the predominating hydrocarbon with some ethane and smaller amounts of propane, butane, pentane and higher members of the series. The latter, if present in substantial amounts, are removed by "scrubbing" to make natural gasoline or so-called cylinder gas. A complete separation of the paraffin series, for analytical purposes, can only be accomplished by low temperature fractional distillation. The sample is liquefied with liquid air and then permitted to distill. The various fractions are collected and measured in the gaseous phase.

Manufactured gas is made from coal, coke, or oil, and its components vary with the type of fuel and the process. In this general type of gas, hydrogen and carbon monoxide are the predominating combustibles rather than paraffin hydrocarbons as in natural gas.

In recent years pipe lines have been extended from the great natural gas fields of Texas and Oklahoma to cities in the north and along the eastern seaboard heretofore served only with manufactured gas. Usually in such instances the two fuels are mixed, resulting in a cleaner gas of higher heating value.

An interesting development in the production of liquefied butane and propane from natural gas has been the utilization of this product in supplying fuel to small communities isolated from the natural gas fields and too small to justify production of manufactured gas. In some instances a tank car of the liquid fuel is placed on a siding and connected to the distributing pipe system, while in other cases each home has its own underground tank which is periodically filled from a tank truck.

In the Pittsburgh district, the analysis of mine air is of substantial importance and, in some instances, is a matter of daily routine. Proper ventilation of a coal mine involves not only the matter of supplying fresh air to the underground workers but of supplying it in sufficient quantities to prevent the accumulation of explosive mixtures of methane or marsh gas, which in

FUEL GASES

Average Composition in Per Cent.

Gas	CO_2	Ill.	O_2	CO	H_2	CH_4	C_2H_6	N_2
Natural	0 to 0.3	------	------	------	------	98 or more		1 to 2
Producer	4 to 12	------	------	15 to 28	8 to 18	2 to 6	------	45 to 55
Blast Furnace	10 to 15	------	------	25 to 30	1 to 3	------	------	55 to 60
Coke Oven	1.5 to 3	2 to 5	Trace	5 to 8	45 to 65	20 to 36	1 to 2	1.5 to 15
Blue or Water	3 to 6	------	Up to 1	40 to 45	45 to 55	0.5 to 2	------	2 to 6
Carburetted Water	4 to 6	8 to 10	0.5 to 1	30 to 35	30 to 35	5 to 15	2 to 3	5 to 10

normal mine air is usually the most troublesome contaminent. The lower explosive limit of methane is five per cent by volume. In case of mine fires or explosions, mine air may contain methane, hydrogen, carbon dioxide, carbon monoxide, nitrogen and oxygen.

The quantitative separation of a mixture of such gaseous components is based upon the fact that certain liquid reagents will absorb some of the components without materially affecting those remaining, and also that those components for which there is no absorption reagent may be determined by combustion.

If, for example, the gas mixture contains carbon dioxide and we bring the mixture into contact with a solution of potassium hydroxide, the carbon dioxide will be absorbed and the contraction in volume of the sample will represent the amount of carbon dioxide in the mixture.

Illuminants may next be removed through the use of fuming sulphuric acid; oxygen by oxsorbent or alkaline pyrogallol; and carbon monoxide by cosorbent or cuprous chloride. The determinations are made in the order given.

Certain combustible components such as hydrogen, methane and ethane either cannot be absorbed by liquid reagents or they are preferably determined by combustion. In this operation the gas is burned in a closed chamber by means of a hot platinum wire, usually in the presence of added oxygen. Hydrogen burns to water; methane and ethane to water and carbon dioxide in accordance with the following reactions:

$$2H_2 + O_2 \rightarrow 2H_2O$$
$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$
$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

By measuring the contraction in volume of the sample after burning and determining the amount of carbon dioxide produced, the percentages of the components present are readily calculated.

Only certain combinations of combustible components when burned will yield the necessary data for calculating the percentages of each that may be present. When confronted with a combination such as hydrogen, methane and ethane which cannot be calculated, we turn to copper oxide which at a temperature of 290-300° C. will oxidize hydrogen to water without affecting methane or ethane. Therefore, in such a case the hydrogen is determined in the copper oxide tube, followed by the determination of methane and ethane by slow burning over a platinum coil.

Carbon monoxide is a convenient and helpful component in that it may be determined by absorption, slow combustion, or by combustion with copper oxide.

The following tabulation gives the reagents and methods employed in gas analysis.

METHODS OF GAS ANALYSIS

Components	Methods	Reagents
Carbon Dioxide	Absorption	Potassium Hydroxide Solution
Illuminants	Absorption	Fuming Sulphuric Acid
Oxygen	Absorption	Oxsorbent or Alkaline Pyrogallol
Carbon Monoxide	Absorption Slow Combustion Copper Oxide Combustion	Cosorbent or Cuprous Chloride
Hydrogen	Slow Combustion Copper Oxide Combustion	
Methane	Slow Combustion	
Ethane	Slow Combustion	
Nitrogen	By Difference	

Illuminants is a name given to a group of components which cannot be separated by the usual absorption and combustion methods. They include unsaturated hydrocarbons such as ethylene, propylene, acetylene, etc., and some ring-series vapors such as benzene. This group occurs in some gas mixtures and is removed as a whole in fuming sulphuric acid.

The residual gas, after the removal of the other components, is assumed to be nitrogen and this component is always figured by difference.

Figure 1 illustrates a modern apparatus for analyzing gas. It comprises essentially a burette for measuring gas volumes, various glass vessels called pipettes for treatment of the sample, and a manifold which provides a closed path between the burette and the pipettes.

The burette, usually of 100 ml., capacity graduated in 1/10 or 1/5 ml., is enclosed in a glass water jacket to keep the gas sample at the same temperature throughout the analysis. Inasmuch as multiple volume measurements are made in an analysis it is obvious that serious errors will result if the measurements are made at different temperatures. Usually in the time required

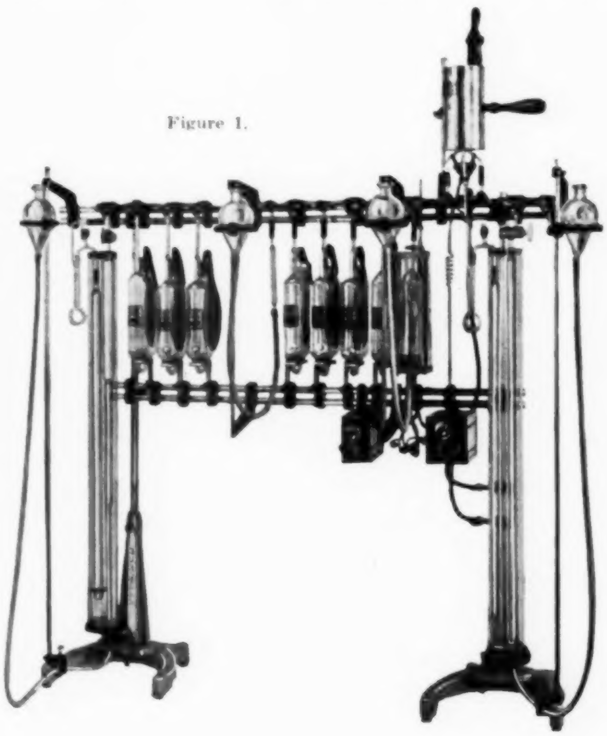


Figure 1.

for a single analysis the temperature change in the water jacket will not be of significance.

Figure 2 shows an absorption pipette of the contact type. The front chamber is filled with glass tubes and terminates in a small bore tube which connects to the manifold through rubber tubing. In use the rear chamber is closed with a rubber expansion bag.

When gas is forced into the front chamber, the glass tubes wet with reagent are exposed to the incoming sample presenting a large surface for quick absorption. As the liquid drops in the front chamber it rises in

Figure 2.

Figure 3.

Figure 4.

the rear chamber, the displaced air from the latter moving into the expansion bag. The bag effectively prevents contact between the reagent and the atmosphere.

Figure 3 shows an absorption pipette of the bubbler type wherein the gas sample is forced through the reagent in bubble form. The absorption rate is faster for certain components and reagents. in this style of pipette.

This form of pipette is called the "Francis." It is an improved type, novel in that the operator need not turn stopcocks to direct properly the flow of gas inside the pipettes. This is automatically accomplished by a small float valve of glass in the small chamber at the top of the front compartment which closes when gas is forced into the pipette causing the gas to follow the central tube down through the front chamber, emerging in bubble form at the bottom. The valve opens automatically to release the gas for return to the burette.

Figure 4 shows a slow combustion pipette comprising a glass shell, rubber stopper and support post carrying a platinum ignition coil. Provision is made for electrical connections to the coil through the post.

The copper oxide tube is U-shaped, made of glass and mounted above the manifold to provide drainage.

A leveling bottle is connected to the burette and slow combustion pipette to control the confining liquid which may be water or mercury.

Electrical control boxes are provided for the slow combustion pipette and copper oxide tube heater.

Assume that a gas mixture contains: Carbon Dioxide, Oxygen, Carbon Monoxide, Methane and Nitrogen.

The pipette next to the burette is about one-half filled with potassium hydroxide solution, the next with oxsorbent or alkaline pyrogallol, and the third with cosorbent or cuprous chloride.

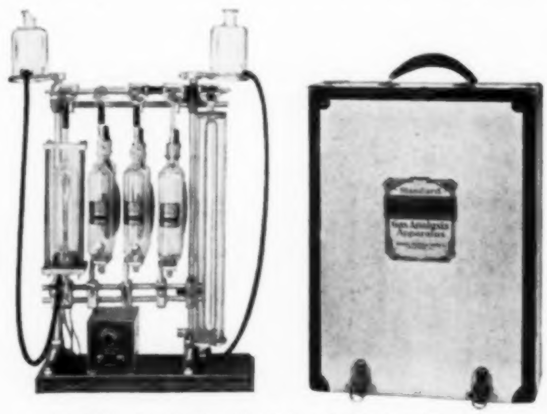
In control analysis, where close accuracy is not essential, water is used as the confining liquid in the burette and slow combustion pipette.

First, the solutions in the pipettes are all pulled up in the capillary connection to eliminate air. This is done by opening the burette to the atmosphere through the top cock, and raising the leveling bottle to fill the burette with liquid. The burette is then connected to the pipette through the manifold and the leveling bottle lowered. This serves to pull the solution up in the pipette.

A sample of gas is next drawn into the pipette and the volume measured. Usually 100 ml. of sample is taken and, in measuring, the leveling bottle is held alongside the burette in such a position that the level of the liquid in the bottle is the same as the level of the liquid in the burette. This insures that the gas at the time of measuring is under atmospheric pressure and all subsequent readings are likewise made so as to avoid errors which would arise if the various readings were made with the gas at different pressures.

The gas is next passed back and forth into the first pipette about four times and the volume again measured. Any contraction is due to the absorption of carbon dioxide.

The sample is then passed into the next pipette sev-



Portable Apparatus Used for Analyzing Flue Gas.

eral times for the removal of oxygen and then into the third pipette for carbon monoxide.

Methane, the remaining component, is determined by slow combustion and oxygen must be added to the sample. One ml. of methane requires 2 ml. of oxygen for burning, or 9.56 ml. of air. Air may be used but, if so, the amount of sample must be reduced, giving rise to a multiplication of errors. An excess of 10 to 15 per cent of oxygen or air is always added.

If the approximate amount of methane present is not

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Unit Planning in Biology

• By Ivan G. Hosack, M.S., (University of Kentucky)
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In the December, 1935, issue of THE SCIENCE COUNSELOR, *Professor Hosack discussed in a scholarly manner the planning of units in biology. Here we present a specimen unit, one selected from the course of study in biology in use in the high schools of the city of Pittsburgh, and which was prepared by a committee of biology teachers under the direction of the curricular research department. It has been slightly modified.*

Careful planning is evident.

This unit provides a good model not only for the preparation of additional units in biology but also for the planning of courses in the other high school sciences.

PART II.

For convenience, the teaching plan which is here presented has been divided into two parts, a plan for the teacher and a plan for the individual pupil.

We regret that limitations of space do not permit the printing of the student's plan in full. Enough is given, however, to indicate the method of use. The student's plan includes a graph similar to that shown in the first part of this article.

Some of our readers may care to know that Professor Hosack is using these plans in conjunction with Baker and Mills, *Dynamic Biology* published by Scott, Foresman and Company.

—The Editor.

UNIT VIII.

HOW PLANTS AND ANIMALS BEHAVE
(Teacher's Guide)

"Tell me what you eat and I will tell you what you are." Just how much truth is in this statement could well be questioned. But suppose we reword the senence somewhat after this fashion: "Tell me how an organism reacts to certain stimuli, under certain conditions, and I will tell you whether the reaction is chance, mechanical, or rational; whether it is unlearned or learned; in other words, how intelligent the organism is. How and why plants and animals behave as they do should be a most interesting study to any normal boy or girl of high school age. The mystery of life bound up in a shapeless piece of minute protoplasm, that the bio-chemist with all his knowledge has not been able to duplicate, should prove to be a lesson long to be remembered."

I.—Purpose of the Unit

From a study of this unit the pupil should come to an understanding that plants as well as animals are alive; that they are alive because the protoplasm of which they are made is alive, sensitive, irritable to the various stimuli which are a part of their environment. Such an understanding should better acquaint the pupil with his own responses, and help him when necessary to make modifications in these responses which will aid him in becoming a more rational individual.

II.—Content

A. **Plant behavior:** That plants are really alive and respond to various stimuli can be used as a motivating influence.

1. Tropisms—As many demonstrations as possible to illustrate the various tropisms of plants should be set up. Seedlings of corn, peas, climbing lima beans, etc., should be started a week or so in advance so as to have them ready for this study.
2. Some of the tropisms of animals should be demonstrated so as to compare them with the tropism of plants. If a good healthy culture of paramecia is on hand, phototropism, chemotropism, and thermotropism can be demonstrated nicely.

B. **Animal behavior:** The tropism, reflexes, instincts, memory, and reasoning of animals make a very interesting study.

1. Discuss and demonstrate, if possible, these various forms of behavior of animals.
   a. Earthworms can be used to demonstrate some of the **tropisms** and **reflexes.** (It is sometimes difficult to distinguish between tropisms and reflexes. This fact can be made use of in provoking interesting arguments and worthwhile thought.)
   b. **Instincts** can perhaps be best learned by discussions and oral reports of examples seen by the pupils themselves. Examples given in the text are very good ones and should stimulate recall as well as imagination.
   c. **Memory.** The social life of bees, ants, termites, etc., illustrates the instincts and memory of the lower animals.
      (1) An ant observation nest, or if possible an observation bee hive will be of unusual interest.
      (2) Mice can be kept in cages and their ability to remember demonstrated.
      (3) Mazes can be constructed by pupils and experiments with different types of animals to test their memory ability can be carried on.
   d. **Reasoning.** The difference between memory and reasoning can be made an interesting discussion:
      (1) Reasoning
         (a) Insects.
         (b) Fish.
         (c) Birds.
         (d) Lower mammals.
         (e) Dogs.
         (f) Horses.
         (g) Man.

C. **Nervous mechanisms in animals:** The relation between the position of an animal in the animal kingdom and the complexity of its nervous system should be emphasized. The responses of man to various stimuli. Most attention should be given to the nervous system of man.

D. **The human nervous system:** By means of models, charts, mannikins, lantern slides, films, etc., the following should be emphasized:

1. The ways in which man is served by his nervous system.
2. The structure of man's nervous system. (This should not be made too detailed or extensive.)
3. The operation of man's nervous system.
   a. The pupil should, by this time, be able to distinguish between reflexes and instincts and apply this knowledge to his own reactions.
   b. Sufficient knowledge of the structure of the sense organs to understand their functioning should be required.
   c. Habit formation and its laws.
   d. Intelligence and how it is measured.
   e. How learning takes place—practical application.

III.—Desirable Outcome

A. **Attitude worthy of development** from the study of the behavior of plants and animals.

1. Appreciation of
   a. Response of protoplasm to stimulation.
   b. Necessity for the response to touch and its importance in the struggle for existence.
   c. Widespread character of the response to taste stimuli.
   d. Primitive nature of a sense of smell in the struggle for existence.
   e. Part played by response to sound in man's development.
   f. Part that light plays in stimulating protoplasm to activity.
2. Realization of the primitive character of reflex action.
3. Realization of one's responsibility in the formation of habit.
4. Realization that mental activity is an essential part of our existence.
5. Cultivation of an interest in the behavior of plants and animals and a disposition to inquire into its significance.

B. **Skill.**

1. Ability to prepare demonstrations to illustrate the various tropisms of plants and animals.
2. Ability to demonstrate simple reflexes of animals.
3. Ability to put into effect efficient methods of learning.

**4. Ability to demonstrate by means of experiments acuteness of man's senses.

**5. Ability to teach a pet a trick.

**6. Ability to break a bad habit and form a good one.

**7. Ability to score an intelligence test and work out an I. Q.

C. **Understanding of the biological principles.**

1. **Irritability** is a fundamental property of protoplasm and is especially well developed in certain cells, organs or groups of organs called systems; that everything a plant or an animal does is a reaction to some stimulus, the result of some force which is the reason for its behavior.
   *a. There are many different kinds of stimuli to which living things respond.
   b. Different kinds of living things respond to the same stimulus in different ways.
   c. Light, heat, gravity, moisture, chemicals, odor, touch, electricity, and air vibration affect living things.
   d. All living things do not respond to all kinds of stimuli. Some animals do not have sense organs which are sensitive to certain kinds of stimuli.
   e. All living things do not respond to a certain stimulus in the same way.
   f. An inherited response which is not varied according to the circumstances nor subject to any modification and which can take place in living things possessing no nerves is called a tropism.
   g. A reflex is an inherited response which is mechanical in nature and brought about through the action of certain neurones.
   h. An instinct is an inherited response of the animal as a whole: it is a type of general behavior in response to a stimulus.
   i. A response may be the result of past associations and trial and error.
   j. Some responses are automatic and are brought about through association and repetition.
2. **Behavior is intelligent** when it shows that an organism has profited by experience.
   a. Reflective thinking is the highest type of response.
   b. Living things differ in their behavior because they differ in ability to respond to stimuli.
   c. The extent to which a living thing can respond to stimuli is determined by the degree of development of its nervous system and its sense organs.
   d. Man is capable of the highest types of behavior because he has a nervous system far superior to that of all other animals.
      (1) Man has large areas in the brain which are not mapped out at birth, and which are capable of being modified by experience as development proceeds from infancy to adulthood.
      (2) Man can consciously form and break habits, that is, tendencies to act automatically when a given stimuli is presented.
      (3) Because man can communicate his experiences to others, he is able to profit by their experiences and thus modify his behavior.
      (4) Man can reflect, that is, he can put a series of experiences together and thus plan a course of action leading toward a specific goal.

IV.—Teaching Helps

A. **Notes to Teachers**

1. It should be kept in mind that about fifteen periods have been allotted to the study of this unit. Emphasis, therefore, should be placed on those essentials which best develop the principles, and attitudes set up for the unit.
2. Many more laboratory activities are included in the pupil's guide than time permits to carry out. It is assumed that the teacher will make use of those he considers best and for which materials are most readily obtained.
3. Some of the suggested activities not practical for classroom work can well be assigned as home problems, and thus take care of individual differences.
4. Some of the experiments on the pupil's sheet call for use of pets, insects, earthworms, fish, etc., which it is assumed will be brought to the class by pupils.
5. A good culture of amoeba, paramecia, hydra or rotifera should be kept on hand for use in this unit.
6. Practical application of how learning takes place may be made one of the most valuable outcomes of this unit.

*Pieper, Beauchamp, and Frann. **Teacher's Guidebook** for **Every-day Problems in Biology.** pp. 198-207.

**For students desiring to do extra or additional work.

B. **Teacher References.**

1. **Wheat & Fitzpatrick,** *Advanced Biology.*
2. **Curtis, Caldwell & Sherman,** *Biology for Today.*
3. **Needham,** *General Biology.*
4. **Wheeler, W. M.,** *Social Life Among Insects.*
5. **Eikenberry & Waldron,** *Educational Biology.*
6. **Holmes, S. J.,** *Evolution of Animal Behavior.*
7. **Watson, John B.,** *Behavior, An Introduction to Comparative Psychology.*
8. **McMurray, Frank,** *How to Study* and *Teaching Children How to Study.*

C. **Visual Aids.**

1. *Motion Pictures.*
   a. Ants, Nature's Craftsmen, 35m and 16mm., 1 reel M505.
   b. Honeybee, Producing Food, 16mm., M506.0.
   c. Spiders, 16mm., 1 reel, M502.10.
   d. The Study of Infant Behavior, 2 reels. Research by Dr. Arnold Gesell Products Co., Inc., 250 W. 57th St., N. Y.
   e. Accomplishment Tests for Babies, 2 reels. Dr. Charlotte Buhler (same as above).
   f. A Few Tests of Child Intelligence, 1 reel. Ina Craig Sartorius (same as above).
   (Note: The last three are sound pictures and at present would not be practical for use in our schools.)
2. *Lantern Slides.*
   a. Winslow Health and Physiology lantern slides (43), complete with Teacher's Manual, Denoyer-Geppert Co., Ws. 1-Ws. 45.
3. *Charts.*
   a. Arnold Physiology Charts (set of 8) Ap. 1-8, Denoyer-Geppett.

V.—Supplies and Equipment

A. **Supplies.**

1. Seeds of various kinds—corn, radish, peas, lima beans (twining) for demonstrating tropisms in plants.
2. Large sheets of blotting paper (dark).
3. Peat, moss.
4. Growing plants.

B. **Equipment.**

1. Insect breeding cages—2 or 3.
2. Battery jars with wire gauze.
3. Seed germinating boxes—several.
4. Gross, glass plates, 4-in. x 4-in. (pocket gardens).
5. Double-pointed compasses (tactile areas).
6. Arnold Physiology Charts Ap. 1-8 D. G.
7. Winslow Health and Physiology Lantern Slides or Charts with manual Ws. 1-Ws. 45. D. G.

UNIT VIII.

HOW PLANTS AND ANIMALS BEHAVE

(Pupil's Guide)

INTRODUCTION

"If all the members of the plant and animal kingdom could go to school, which ones would wear the dunce cap and which ones would be at the head of the class? Which ones could remember best, which would be the most industrious, and which most clever? We often speak of dumb animals, but sometimes when we see the way animals perform we wonder whether they are so dumb after all. Of course such animals are trained; but, even so, they learn to do things that are new to them and that are sometimes quite unusual.

"The performances of trained animals are no more wonderful, however, than the natural behavior of animals in their native habitats. Wild animals are frequently challenged and, if they are to survive, must devise ways of meeting new conditions successfully. Among other things, they must outwit their enemies, secure food, and adjust themselves to changing conditions. Variations in temperature and moisture, differences in the fertility of the soil, and the attacks of pests and enemies are conditions that must be overcome if plants are to live.

"Because of his ability to control to a great extent the conditions that affect his welfare, man is superior to plants and animals in maintaining himself in a changing environment. Not only can he adjust himself more readily to new conditions, but he can even modify

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YOUR order—no matter how large—no matter how small—has the *immediate attention* and the *immediate service* made possible by our large and efficient organization and complete stocks.

Orders received by nine o'clock in the morning will be delivered the same day, by our large fleet of trucks, operating on regular schedule.

Special delivery service by messenger is maintained for rush emergencies.

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W. J. GILMORE DRUG COMPANY

COMPLETE PHYSICAL, CHEMICAL AND BIOLOGICAL EQUIPMENT

Laboratory Apparatus Division

422 Boulevard of the Allies — Pittsburgh, Pa.

his environment to suit his needs. This is because he relies largely on intelligent behavior.

"The study of behavior is extremely fascinating, and it is hoped that you will enjoy the activities of this unit. Perhaps as you proceed you will come to realize as never before that all forms of life are continually responding to conditions that surround them. To explain just what it is that makes them behave as they do is the problem that confronts you now." Baker and Mills, *Activities for Dynamic Biology.*

I.—Preliminary Exercises

A. How do you account for the turning of leaves toward light; the flight of a moth into a flame; or the breaking of sewer pipe by the roots of some trees?

B. Describe exactly how you felt, and explain what moved your arm when, once upon a time, you touched a hot stove?

C. Give an instance of wholly or nearly instinctive behavior in the human being.

D. Give several illustrations showing that instinctive behavior is inherited.

E. What instances of memory behavior have you ever observed in an animal other than man?

F. Give an instance of a dog or horse showing reasoning intelligence. Are you sure you could not explain it as instinctive or memory behavior? Can a horse count?

G. In which of your subjects in school are you most often asked to use memory? In which are you most often asked to reason?

H. How could you proceed to rid yourself of a bad habit?

I. Which of your senses do you consider most keen? Which one do you consider most useful?

II.—Learning Activities

A. **PROBLEM 1.** How does the behavior of plants indicate that they respond to their environment?

STUDY SUGGESTIONS: In order that we may understand how plants and animals "behave" it is imperative that we thoroughly understand, at the very beginning, the scientific meaning of "behavior," "stimulus," and of "response." In ordinary usage, behavior refers to conduct, either good or bad. But the word "behavior" as used in biology, however, has a meaning different from the ordinary use of the word. For example, in biology one may study the behavior of plants, animals, and men. While ordinary use of the term might apply in the study of animals and men, it is evident that it would not apply to plants. It is the purpose of this problem to show that plants do show certain forms of behavior, and to remind us that the function of behavior is universal among all living things.

Read one or more of the following references:

(1) Baker and Mills. pp. 522-532.
(2) Pieper, Beauchamp, and Frank. pp. 349-380.
(3) Hunter. pp. 420-426.
(4) Kinsey. pp. 615-626.

1. **Meaning of "behavior."**
   a. What is the scientific or biological meaning of behavior?
   b. What is meant by a stimulus?
   c. What is meant by a response?
   d. What is meant by tropism?

2. **Behavior of plants.**
   a. How do you account for the fact that animals react much more rapidly to stimuli than do plants?
   b. In tabular form, explain the mechanical responses or tropisms of plants.

TROPISMS IN PLANTS		
TROPISM	EFFECTS	DESCRIPTION - EXAMPLES

**c. Prepare a report and be prepared to present it before the class on the "Intelligence of Plants." See the Popular Science Library, Vol. 7, Intelligence in Plants.

3. **Conclusion or Summary.**
   a. What is the cause of the reaction or response of a plant that is the reason for its behavior?
   b. What fundamental property of protoplasm, that is present in plants, is explained in this problem?

B. **PROBLEM 2.** How does the behavior of animals indicate that their response to stimuli is controlled by a nervous system?

STUDY SUGGESTIONS: In our preceding problem we have seen that plants have the property of irritability, that is, sensitivity to stimuli. That there are many different kinds of stimuli to which they respond. But do different kinds of living things, such as animals or plants, respond to the same stimulus in the same way? Is there any difference in the response to stimuli of animals without a nervous system and those having a nervous system? When is the behavior of an animal mechanical or instinctive, and when is it intelligent, involving memory and reasoning? The activities of some animals are fairly complex, especially among the social or colonized insects. Are they able to profit by their experiences, or reason a problem out? Or do they simply follow inherited set patterns? To answer some of these questions is the purpose of this problem.

** For students desiring to do extra or additional work.

Read one or more of the following references:

(1) Baker and Mills. pp. 532-550.
(2) Pieper, Beauchamp, and Frank. pp. 349-380.
(3) Kinsey. pp. 617-641; 705-726; 728-750.
(4) Hunter. pp. 422-426; 441-443.

1. **Mechanical Behavior of Animals.**
   a. Make a list of the tropic responses of lower animals to illustrate the various tropisms. Give examples where possible.
   b. What is meant by reflex action?
   c. What are the three chief characteristics of a simple reflex?
   d. What is the difference between a reflex and a tropism?
   e. What is the mechanism of a reflex? State several examples.
   f. What is meant by a conditioned reflex? Show how this type of reflex may be used in teaching tricks to pets. How does Pavlov's experiment illustrate a conditioned reflex? (Ref. 2, p. 372.)
   g. What is the nature of an instinct?
   **(1) Consider an example of instinct, as in the setting of a hen, showing from what reflexes, tropisms, etc., the chain of behavior is built. (See Ref. 3, pp. 628-641.)
   h. Make a comparison between reflexes and instincts. How are they alike, how different?
   i. What are the results of instinctive behavior? Are they always beneficial? Explain.
   **(1) Give several illustrations showing that instinctive behavior is inherited. (Ref. 3, pp. 631-641.) (Ref. 2, pp. 374-376.)
   j. What is meant by organized social or colony life?
   k. In the following examples of social and colony life of (1) honey bees, (2) ants, **(3) social wasps, **(4) bumblebees, and **(5) termites, *describe the different casts* and *their part* in the *division of labor* in the colony.
   l. Make a list of the activities of each of the above insects. Classify them as tropic, reflexive, instinctive, or intelligent.
   **(1) If possible, observe ants and bees at work. Set up an observation ant nest in your class.
   **m. To what kinds of stimuli do living things respond? (Ref. 2, pp. 354-365.)
   **n. What kinds of responses do living things make to stimuli? (Ref. 2, pp. 366-380.)
   **o. Make a chart showing the instinctive acts, reflexes, and acts of intelligence observed in lower animals. Pictures illustrating some of these forms of behavior may be found in magazines and papers.

2. **Intelligent Behavior in Animals.**
   a. What is the meaning of the term "intelligence?"
   b. Show the difference between intelligence and tropisms, intelligence and reflexes, and intelligence and instinct.
   c. Show how memory is a type of intelligent behavior. Give several examples of pure memory. Show how it is of value to animals.
   d. Show that reasoning is a type of intelligent behavior. How does it differ from memory?
   e. Show that animals reason, by stating at least five examples or evidences.
   f. How does the behavior of animals differ from that of plants?
   **g. Read and report from the following references dealing with behavior in animals.
   (1) Hornaday, William T., *The Minds and Manners of Wild Animals.*
   (a) The brightest minds among American animals. pp. 54-61.
   (b) The true mental status of the gorilla. pp 93-100.
   (c) The morals of wild animals. pp. 219-224.
   (d) Wild animal criminals and crime. pp. 286-301.
   (2) Wheeler, William, *Social Life Among the Insects.* pp. 3-91.

3. **Conclusion or Summary.**
   a. State in the form of a principle as to what type of behavior is intelligent.

* * * * * *

Complete details of further problems are included in the outline furnished to the pupil. They will be omitted here.—(Editor.)

PROBLEM No. 3 is *What types of nervous mechanisms are found in various animals?* It is developed under the sub-heads: (1) Animals without a nervous system. (2) Animals with a diffuse type of nervous system. (3) Animals with a central nervous system. (4) Summary.

Continued on Page Twenty-five

You Should Read

Education of the Founding Fathers of the Republic

● *By* JAMES J. WALSH; New York; Fordham University Press, 1935. xii + 370. $3.50.

If any work from the facile pen of Dr. James J. Walsh is always hailed as a worth while contribution to scientific and intellectual research, his latest contribution should be considered as epoch making. If the pendulum of educational methods should ever swing back, Dr. Walsh will have done much to aid the movement.

Delving, as is his wont, into forgotten records, this eminent scholar brings to light the significant fact that almost all the men who signed the Declaration of Independence were college graduates, trained in institutions that held aloft the beacon light of sound education amid the lowering clouds of almost a century of struggle.

The reader is next introduced to the secret of their success; it is found in the curricula of the schools. A significant fact, either forgotten or unknown in our day, is established beyond the shadow of a doubt, namely, that scholastic philosophy was the basis of all instruction and education; that scholastic ethics, taught usually by the president of the college, held the place of greatest honor. Commencement exercises were featured by Latin disputations. In a word, the method followed in the early days of the Republic was that which obtained in the European universities since the Middle Ages, and which still obtains in many of them to this day.

It seems to me, however, that the real, the priceless value of "*Education of the Founding Fathers of the Republic*" is to be sought in the two concluding chapters. Here the reader is shown the change to our modern method, and the irreparable loss to education therefrom.

The twelfth chapter, Life and Education, tells us, with an objectivity that must confound; confounding, must irritate; and irritating, must convince the most ardent advocates of our educational frills and follies, that the change has plunged us into an era that can justly be called the "Dark Ages." The principles of ethics have been set aside, and our generation is being taught how to make a living "at any cost," but is not being taught how to make a life. I would suggest that every educator and every high school and college student be made to study *and study well* every word of "Life and Education."

Dr. Walsh has rendered a signal service to the cause of education and to that of scholastic philosophy.

Rev. James F. Carroll, C.S.Sp.,
Duquesne University.

The Story of the Plant Kingdom

● *By* MERLE C. COULTER; University of Chicago; University of Chicago Press, 1935, vii + 270. $2.50.

The Story of the Plant Kingdom is the botanical response to the "Chicago College Plan" designed to give the student a "respectable minimum of general education." Those who fear that the reorganizations of course material now occurring in this country may be but extra sugar on an already overcoated pill will be gratified to find that Dr. Coulter, as far as botany is concerned, has contributed a minimum to general education that is very respectable indeed.

The intrinsic value of any of the "new plans" over older methods may well be argued since the success of either depends entirely upon the ability of the teacher. The good teacher tells his story by any method and Dr. Coulter has done just this for the plant kingdom for students under the new plan of Chicago; which perhaps and after all was not so new to him or to other teachers of equal literary and pedagogical skill.

New necessities, perhaps immaterial in themselves, may serve as stimuli that result in desirable effects. Such are frequently needed to clear away our academic cobwebs and to force us to view our teaching problems from new angles.

What do we have to tell that is important; what is the indispensible minimum of facts that will support the dignity of our informational superstructure; how are we to present these facts?

These questions Dr. Coulter has answered by deciding that a phylogenetic sequence is necessary to develop the big fact of evolutionary development. Phylogeny, however, becomes no wearisome recitation of names and of inconsequential structures but rather a parade of anatomy that functions, of organic simplicity that turns understandably into increasing complexity.

No fact of plant life worth while in a general education is omitted despite the brevity imposed by its 257 pages of text. This statement becomes more impressive when we study the Index made up of 11 pages of closely placed and double-columned references. The illustrations are newly drawn, simple, clear and plentiful.

The author cannot quite break with a past tradition that requires that all be told, and crowds the bottoms of many pages with foot notes that are irritating in any book regardless of who wrote them. He is not unaware that footnotes, occasionally taking up two-thirds of a page, are a bit on the generous side but he feels that their qualifying values are desirable.

This is a new book that is a happy addition to an already large family of college texts on general botany. It will inevitably cause its professional readers to wonder what they can do toward eliminating dead wood from their own courses.

Robert T. Hance,
University of Pittsburgh.

A Mathematician Explains

● *By* MAYME I. LOGSDON, Associate Professor of Mathematics, University of Chicago; University of Chicago Press, 1935. ix + 175. $2.00.

The question of what a latter day college education should be and how it should be imparted, is arousing more and more active interest throughout the country. A growing chorus complains that things as they are, are bad; could not be much worse. With the advance of science, especially of technical science, the complacent stability of quasi-higher education of a century or less ago has disappeared. The humanities have been shoved to the background or altogether offstage, their place taken to an increasing extent by the sciences. And as science is getting awfully long, and college life is short, college teaching has turned into pumping an unnaturally complex stream of scientific wisdom into the naturally simple brains of assorted undergraduates. The effect is pathological.

Universities are awakening to the necessity of doing

something about it, some are boldly experimenting. Among the latter, the University of Chicago is trying a New Plan, and Professor Mayme Logsdon's book, illustrated by smart Chichi Lasley, is primarily a contribution to the Chicago Plan.

It is a general review of mathematics and its history, from arithmetic through Cartesian geometry and the calculus. Professor Logsdon makes an effort to be entertaining, and is successful in a surprising measure. To allure college humans to mathematics, she tries to make mathematics human, in spots personal and intimate. She tells of Plato refusing hospitality to anyone ignorant of geometry, she tells of the algebraist Cardan stealing Tartaglia's secret thunder of the cubic equation, she tells of the bitter row between Newton and Leibnitz, she quotes modest Mahavir bragging of himself as one of the "accomplished holy sages, who are worthy to be worshipped by the lords of the world," and much else the like.

And Mrs. Lasley, with her decorative drawings, does her own good bit to keep boredom away. To illustrate "Mathematics an Abstract Science" she exhibits a half-nude caveman tending two artificial sheep, three wooden horses. We like her picture of squatting Aryabhatta, Indian inventor of the zero, although Aryabhatta's wiry Chinese hair does suggest a probable error in his ancestry. On page 25, the algebraic illustration "Mary learns minus numbers" is sweet. In the second half of the book most of the figures are just conventional—not Mrs. Lasley's, we guess.

A great majority of the subjects are written with transparent clearness. To be sure, the nutshell treatment of non-Euclidian geometry may look to the unsophisticated coed as clear as mud, and a point or two of the author's logic of mathematics may not hit *any* sophomore's right spot. But mostly, again, the book is clear, and entertaining, and really informative. Whatever the reader's occupation, and very especially if it be the teaching of ordinary mathematics or science, he will profit by owning, reading, even studying the book, for the Mathematician does Explain.

M. A. Rosanoff,
Duquesne University.

Handbook of Chemistry and Physics Twentieth Edition

● *By* Charles D. Hodgman, M.S. and Norbert A. Lange, Ph.D. Chemical Rubber Publishing Co., Cleveland. 1935. $6.00.

This "one-volume scientific library" should be on the desk of every teacher of chemistry or physics and in every school library. Between its covers is found a wealth of up to date and dependable scientific and technical data covering the major fields of science, including chemistry, physics, geology, biology, engineering, metallurgy and mathematics. Some of the material presented is not readily available elsewhere.

The *Handbook of Chemistry and Physics* is revised yearly. The fact that the twentieth edition is now ready is alone sufficient evidence that this is a most valuable book. The present edition contains considerable information not given in previous editions and the book has been improved in many ways. New features include a table showing the pronunciation of many chemical words, a formula index and rules for naming organic compounds, and an enlarged and improved table of the physical constants of some 5500 organic compounds, including when possible their accepted names under the rules of the International Union of Chemistry.

The information in this reference book will be of assistance to students, teachers, persons engaged in research, and workers in technical fields.

H. C. M.

Our Physical World

● *By* Elliot R. Downing. New York. Longmans, Green & Co., 1929, xviii + 368. Illustrated. $2.00.

Our Living World

● *By* Elliot R. Downing. New York. Longmans, Green & Co., 1933, xxi + 503. Illustrated. $2.00.

Science in the Service of Health

● *By* Elliot R. Downing. New York. Longmans, Green & Co., 1930, vii + 320. Illustrated. $2.00.

Here is a different kind of science textbook, one designed for the teacher rather than for the student, although every high school student can use any of them to advantage.

These three books are *source books*, rather than teaching texts. In them the author has brought together and made easily available much scientific information that it might be quite difficult for the individual science teacher to find for himself.

Such books as these give the teacher background material. They teach him some of the little but important practical things that he should have learned, but that he may not have met, in his own advanced study because the instructor took them for granted. They provide him with answers to the sensible and pointed questions his pupils are likely to ask, answers which he is embarrassed not to know.

In these books Dr. Downing shows how natural materials, animate and inanimate, can be made to serve educational ends. He demonstrates the manner of tieing up scientific information with the experience of the pupil, of teaching him how to interpret nature and of giving him an appreciation of the principles of science. Interesting and inspiring bits of the history of science are given so that the beginner may be taught how to think like a scientist by learning how successful scientists have thought out their problems.

Our Physical World opens with chapters on astronomy and geology that will be interesting to all teachers and particularly helpful to the teacher of general science, for these two sciences are no longer as "fashionable" as they once were and many science teachers have not studied them. The interesting chapter on radio communication was written by Fred G. Anibal, Central High School, Kansas City, Mo. Air, fire, water, photography, and electric inventions are among the other chapter headings.

Our Living World is a source book of biological nature study. It discusses animals of pond and stream, insects, birds, animal companions, flowers, seeds, spore bearers and the garden. The manner of treatment may be shown by the chapter on animals of pond and stream. Sails, clams, crayfish and other crustaceans, dragon flies, mosquitoes, water-bugs, frogs, toads, turtles and fish are considered. In studying crayfish, the topics discussed include armor, eggs, gills, walking, food, breeding, the young, and molting.

This book has a bibliography at the end of each chapter. This is an improvement over *Our Physical World* which has a general book list at the end, and over *Science in the Service of Health* which has no bibliography at all. The latter book is the least useful of the three. It presents interesting and little known facts in the history of science as applied to medicine from the time of Hippocrates to the present day.

Like all books dealing with science these books must be revised periodically so as to bring them up to date. The great mass of information they contain, however, will not become antiquated. Every teacher of science should have access to them. Every teacher will enjoy

reading them, for they are written in a delightfully intimate manner.

Dr. Downing, the author, is associate professor of the teaching of science in the school of education at the University of Chicago. He is general editor of the Longmans School Science Series of which these books are a part.

H. C. M.

Cultural Value of Science

Continued from Page Six

and exactness it gives to the student in the use of his reasoning powers. The area of science extends over a vast field of subject matter comprising not only experiments, but problems, laws and theories as well. The mind is exercised in many ways in a huge and diversified field of knowledge. It must inspect and weigh scientific theories and terms; it must accept and discard; it must prove the truth and convict the untruth. As a result of such mental culture, the student's reasoning is bound to become more logical so that he may be able to draw right conclusions not only in science but on ordinary occasions when an opinion or a decision is to be made on a problem of everyday life. More readily will he seek the truth and more easily will he find it. In fact, the truth will become so much a part of him that he will develop a real love of the virtue of truthfulness.

The imagination, too, is cultivated and enriched by the study of science. In solving his problems and working out his experiments the student must imagine all possible solutions and reactions before reaching his final decision. He must visualize the reactions taking place behind the exterior occurrences and base his scientific procedure upon this visualization. To accomplish this, the creative powers of the mind must be called into play and in this respect, the science student becomes an inventor. Each time the student arrives at a conclusion, he discovers, and persistent work of this kind does much to develop those faculties leading to discovery and invention. The student is thus taken above his humdrum existence and is given an opportunity to appreciate the material as well as the intellectual excellence of his surroundings.

For the Catholic student these cultural values have a greater and deeper significance. Every Catholic teacher makes it a point to correlate science and religion and to lead the student from an appreciation of the universe to an intense love of the Creator who has made all things according to weight, and number and measure. Through the greater power of thought, the stronger grasp of things intellectual, the broader mental vision given by the study of science, the student acquires a broader and more sympathetic view of life by which his soul learns the workings of God and thus more fully comprehends God Himself. He is enabled to see with clearer vision the relation established by the Creator between the material order and the spiritual, between human legislation and God's eternal law.

The Glacier Priest

Continued from Page Five

volcanic activity. Under the tutelage of an eminent geologist, Rev. Paul Galtes, S.J., and accompanied by him on his expeditions, he had opportunities to explore and examine eastern Washington (Columbia River Basin), Idaho, Montana and Wyoming, including Glacier and Yellowstone National Parks.

Entered at the University of Innsbruck, Tyrol, Austria, for his professional theological studies in 1921, he found himself in the heart of the Alps for four years, with glaciers less than a day's trip away in various directions. So persistently did he use all his holidays and his seasonal vacations in the indefatigable exploration of glaciers that the simple, rugged mountain folk who furnished him with guides admiringly gave him the sobriquet of the Gletcher-pfarrer, which in its English equivalent of the Glacier Priest is the name by which he is widely known today.

During 1925-26 he was in the Mid-Atlantic States, spending his time chiefly at Poughkeepsie, on the Hudson.

In 1926 he returned to Santa Clara University, California, where he taught geology to college students. He now turned his attention to Alaska as a field for geological research and exploration. Summer vacation expeditions which he organized and on which he was accompanied by his old friend and master, Rev. Paul Galtes, S.J. and by his college students, became annual events.

Alaska was chosen for several reasons. Its relative proximity to California is evident. Father Hubbard's wide field experience in his subject could be greatly extended by a careful piecemeal examination of the marvelous display of glaciers and volcanoes, great mountains and great rivers, looking out with the naive simplicity of natural forces under circumstances which prevailed over much of the earth's surface when our world was geologically young.

A marked aid to any such venture on his part was the presence in Alaska of numerous members of his order, many of them former class and school mates of his. All the priests in Alaska are Jesuits, laboring in obscure outposts and missions to Eskimo and Indian, or caring for the spiritual and cultural needs of the larger centers and port towns. The presence of these men gave Father Hubbard not one base, but many all over the desolate peninsula.

Since 1930, the University of Santa Clara has permitted Father Hubbard to devote all of his time to the research and exploration which he continues to carry on in the North, and to the writing and lecturing which he does as a consequence.

In prosecuting work of this type, Father Hubbard is in the high tradition of his order. In what is now the continental United States, the names of Kino, De Smet,

and Marquette will come immediately to mind. The Society of Jesus as an organization, has probably contributed more trained and educated observers to the exploration of out of the way portions of the world than any other organization in Western Civilization. The explorational history of North and South America, of India, Tibet and China will bear this out.

Father Hubbard is a part of this tradition, and adds to it a special interest in his own field, that of geology.

"In science read, by preference, the newest works; in literature, the oldest. The classic literature is always modern."—*Bulwer-Lytton.*

The Spirit of Education

Continued from Page Eleven

into towering mountain peaks—the land of future America.

The right-hand processional is led by the stalwart figure of Horace Mann, one hand protecting the little boy with drooping head across whose eyes is a bandage symbolizing blindness. For among Mann's many contributions to society were his efforts in behalf of instruction for the blind.

Beside him stands Mary Lyon. Her untiring efforts to establish higher education for young women were crowned with success in 1837 when she opened Mount Holyoke Female Seminary.

Then comes Henry Barnard, the philanthropist.

With hand raised to direct the singing of a boy and girl is the Beethovenesque figure of the youthful Lowell Mason who was the first to introduce music into American schools.

Next stands John Dewey, and behind him Charles W. Eliot. Completing the procession is Colonel Francis W. Parker who influenced educators to keep the child, and not teaching, uppermost in their thinking.

The background at this side of the mural offers a vivid contrast. Rising into the clouds is the skyline of a modern city. Here is modern, industrial America.

Future Numbers
of The Science Counselor

A few of the many interesting articles which will appear in early issues of THE SCIENCE COUNSELOR are listed:

A Mendel Relic Comes to America

By Dr. Samuel W. Fernberger, Professor of Psychology, University of Pennsylvania.

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The Science Demonstration

By Raymond B. Brownlee, Chairman, Department of Physics, Stuyvesant High School, New York City.

•

Teaching Devices in Chemistry

By Harold J. Tormey, Ph.D., Head of the Department of Chemistry, St. Bonaventure College.

•

Changing Aims in Biology Teaching

By Sister M. Dafrose, O.P., Chairman, Science Department, Bishop McDonnell Memorial High School, Brooklyn, N. Y.

•

Objectives to be Attained as a Result of Instruction in Science

By Dr. Wilbur L. Beauchamp, University of Chicago.

•

Albert the Great, the Scientist Saint

By Dr. Nicholas Dietz, Jr., Creighton University.

•

The Scholastic Classification of the Sciences

By Rev. J. F. Carroll, C.S.Sp., S.T.D., Professor of Philosophy, Duquesne University.

•

Safety in the Laboratory

By I. J. Wernert, Department of Chemistry, Niagara University.

•

Science at the High School Level

By Rev. John F. Hammond, O.S.A., Villanova College.

•

The Museum in Science Teaching

By Dr. Andrey Avinoff, Director, The Carnegie Museum, Pittsburgh.

•

Other Articles by

Sister Mary Dorcas, S.C., Ph.D., Seton Hill College.

Dr. T. C. May, Department of Geology, Catholic University.

Mr. E. S. Russell, Cambosco Scientific Co., Waverley, Mass.

Dr. A. C. Noé, Associate Professor of Paleobotany, University of Chicago.

Miss M. Gertrude Blanchard, Librarian, Duquesne University.

Mr. William Helfrich, Titusville High School, Titusville, Pa.

Unit Planning in Biology

Continued from Page Eighteen

PROBLEM No. 4 is *How does the nervous system in the human body function?* It includes: (1) Purpose of the nervous system. (2) Divisions of the nervous system. (3) Operation of man's nervous system. (4) The five senses—how we come in touch with the world about us. (5) Suggestions for debates. (6) Summary.

* * * * * *

III. Reorganization and Achievements.

A. **Be able to pronounce,** spell and use correctly the following words:

irritability
stimulus
response
tropism
phototropism
hydrotropism
geotropism
**thigmotropism
**chemotropism
thermotropism
reflex
instinct
memory
reasoning
intelligence
habit
**original nature
**mental age
**chronological age
**intelligence quotient

neuron
**axon
**dendrite
sensory neuron
motor neuron
**associative neuron
ganglion
plexus
synapse
brain
cerebrum
**hemisphere (of brain)
cerebellum
medulla oblongata
**cortex
convolutions
spinal cord
auditory nerve
olfactory nerve
optic nerve

**outer ear
**middle ear
**inner ear
**tympanic membrane
**hammer
**anvil
**stirrup
**cochlea
**Eustachian tube
**pupil
**iris
**vitreous humor
**aqueous humor
**retina
**lens
**taste buds
**radial nerve
eyespots
sensitivity

B. **Self-testing Exercises.**

1. Give examples of behavior in plants that illustrate the various tropisms.
2. If plants do not have a nervous system, how do you account for a plant's response to a stimulus?
3. Give examples of behavior in animals that illustrate the various tropisms.
4. Explain the mechanism of a reflex action. Give some examples of reflex actions. How do they differ from tropisms?
5. What is the nature of instinctive behavior? Give some example of instinctive behavior and give their origin if possible.
6. Why are tropisms, reflex actions and instinctive behavior classified as "mechanical behavior?"
7. Do you consider the ants an intelligent race of insects? Give reasons for your answer.
8. What are two phases of intelligence? Give examples of each.
9. Why are pure memory questions on an examination not always a good test of an individual's intelligence?
10. Do you believe there exists a positive relation between memory and reason? Why?

(*A Number of Exercises Are Here Omitted—Editor.*)

11. Discuss briefly the development of the nervous system from the protozoa to vertebrates.
12. State four ways in which man's nervous system serves him.
13. What are neurons? Describe them.
14. How is a synapse formed? What is its importance in the behavior of man?
15. What is your idea of plexus? Where is one located in the body?
16. Name three reflex actions of man. Name three instinctive actions.
17. State the laws of habit formation. What is the importance of habits to man?
18. What is involved in intelligence? How is intelligence measured? What is meant by the curve of intelligence?
19. Name the five senses of man and the sense organs of each. Where does the actual hearing take place—in the ear or in the brain?
20. Formulate a statement with respect to the sensitiveness of plants and animals, which might be considered as a principle of this unit on plant and animal behavior.

C. **General Conclusion.**

1. Facts, principles, or generalizations.
   a. Make a list of all the important principles, main ideas, or generalizations of biology which you understand as the result of this unit. Example:
      (1) All protoplasm has the property of irritability, that is, sensitivity to stimuli.
   b. You will be asked to prepare an outline, summary, or other form of report of the entire unit, without the aid of your notebook or other reference.
2. You make a collection of clippings and pictures from newspapers and magazines. These may be pasted in your notebook, making it up to date in current biology, as well as making it more attractive.

D. **Additional Topics:** You will be permitted to do additional work in such form as you and your instructor decide upon. This will be optional.

The End

With The Editor . . .

Continued from Page Four

practically obliged to give free textbooks in our parallel high schools, especially at the present time when so many in this section are out of work."

Obviously, the lending of textbooks free to students in the Catholic schools has the same merits and defects that are to be observed in the public schools. A well informed correspondent makes this statement:

> "It is my personal opinion that free textbooks are in almost every case preferable to either the rental plan or purchase by pupils. My opinion, however, is at variance with that of many people whose opinions I respect. Against the free textbook plan its opponents offer the objections that:
>
> 1. Pupils are required to use soiled and torn books.
> 2. The child loses the advantage to be gained by possessing a book of his own.
> 3. It relieves the child of the responsibility of good care.
> 4. It makes it more difficult to change the adoption.
>
> "In my opinion these objections are partly imaginary and against them there is an economic advantage. When children buy books through dealers, the dealer's profit is always added. Free textbooks are purchased by the school at the lowest wholesale price. Moreover, there is an advantage in having books as school property in that they are available for distribution and use on the first day of school, with every pupil provided with a copy. In pupil-owned systems it is often weeks or months after the opening of school before every child is equipped, and doubtless there are many cases where some in the class never have access to any except a borrowed copy.
>
> "I might add parenthetically that many publishers oppose free textbooks on the theory that they sell fewer books in such systems. I do not know whether that is sound reasoning or not."

The chief objection to the free book plan so far as the Catholic schools are concerned, is expense. Just now many pastors are unable to undertake additional financial burdens. Nevertheless, several superintendents of schools in the East believe that the project is not too expensive for the average school to undertake at the present time. Twice as many believe it would be. At least eleven dioceses not now operating under the plan, approve it, and believe its use should be encouraged. A small minority of superintendents vote against it. One publisher makes a militant suggestion that will find approval in every parish. He believes: "Action should be begun to have the child in the Catholic school treated on exactly the same level as the child in the public school and obtain free books from the state; that is, of course, where free books are supplied by the state or the local school authorities. In other words, bring about the Louisiana Free Book Law in any locality where free books are supplied."

The rental system is a substitute for the free book plan. The school purchases and owns the books and rents them to pupils for a certain fee per year. This plan is now in satisfactory operation in the high schools of at least six dioceses. A considerable number of superintendents in other dioceses believe that the plan is a good one and would use it if it could be afforded. Only four dioceses voted against the rental system; and two of the four now supply free books. One diocese approves it for use in the case of elective subjects only.

It is apparent that the rental system has certain defects that are inherent in the free book plan. Expense is again an important factor. One superintendent believes that the plan is worth while for a number of reasons, among which may be included that "students are taught respect for the property of others by the fines charged against them for damage to their books." He suggests that the schools that use the rental plan will be more likely to have up-to-date books. A publisher who disagrees with him says: "For the Catholic high schools the rental system would be the easiest, but it has the disadvantage of keeping out-of-date books too long in service."

Publishers generally are not enthusiastic about the rental plan. One says: "Some 25 or 30 years ago this plan was quite common in many 'academies.' As an economic measure at the present time it might be considered." Another publisher gives the plan faint praise: "I don't think it very wise to encourage a rental system although a rental system is better than no books at all."

A third publisher believes that in the Catholic schools, where the administration is of a different order and where the question of politics does not complicate the textbook situation as is sometimes the case in the public schools, it seems reasonable to believe that a rental system might work satisfactorily.

The Catholic schools do have a textbook problem—a most important problem which needs closer and more serious study by those in charge. In some respects the situation can be improved almost immediately without expense, but the big changes that must come will cost money. Catholics are accustomed to sacrifice. Their whole school system shows that. Even greater self-denial must be practiced by our people if free textbooks are to be supplied. *Eventually they must be*, if the drawing power and the holding power of the Catholic schools are not to decline. That cannot be permitted. Some parishes are now financially able to stand this additional expense. They should lead the way.

Undoubtedly the day will come when the same free book system will prevail in both public and parochial schools, but that time is not immediately at hand. In the meantime, by cooperation and through the well directed and careful work of committees of competent and willing teachers, our schools can do much to improve the present situation by insuring that by whatever means they are supplied—free books, rental system, or individual purchase—our Catholic pupils shall have a good supply of well selected books that are up-to-date and that are the best of their kind.

THE SCIENCE COUNSELOR acknowledges with gratitude the courteous assistance given in this study by the Reverend Paul E. Campbell and the other diocesan superintendents of schools, by the textbook publishers and their representatives, and by the teachers in the Catholic schools.

Supervised Study

Continued from Page Ten

warded only according to his achievement. Consequently, everyone works, not because he has been told to in so many words, but largely because he has been given impetus in the first part of the period—he has been trained to. From the very beginning every student must be made to understand that a study period is a work period; that he must go to work at once and keep at it until his task is completed. The teacher is there to see that this is done. If students are *expected* to study, and the fashion of work is set from the first day, they soon "get the habit," but the study room teacher will have little opportunity to sit down during the first few weeks, and must never become a stationary fixture.

Finally, and most important of all, this kind of group study with the teacher is kept up until the majority of the class can read a paragraph understandingly enough to find unhesitatingly the answer to a definite question. Then—*and not until then*—they are ready to be taught to use a furnished outline.

It may take only three or four days for a "rapid progress" section to reach the second level, from two to five weeks with an "average progress" group, but the "slow progress" section of the seventh grade may need as much as ten weeks' work before they are ready for the second step. Much of the difficulty encountered later in teaching these children comes from neglecting or hurrying over this first simple preliminary training in careful, analytical reading.

Even this first step in supervised study, if successfully carried out, demands fully as much preliminary thought and careful planning on the part of the teacher as any recitation does. No teacher can conduct a supervised study period efficiently without having made definite preparation—a carefully worked out assignment; a list of references to definite pages of text material, plus questions, outlines, or similar study guides which the students will use in their individual work; a vocabulary list of new technical terms, to be placed upon the board for preliminary class drill in pronunciation and spelling; sketches or diagrams if needed, on the blackboard or permanently mounted as the case may be; specimens, samples, or other illustrative material when any is necessary. If the subject teacher hears recitations only, and the study period is in charge of another teacher in a study hall, it is the job of the subject teacher to pass over this prepared material, and to indicate exactly how it is to be used.

The writer wishes to make clear that this article is not intended as an exposition of science method. Its aim is to call attention to some important details in beginning to train children to study by themselves, whether in science texts or elsewhere. It has been taken for granted that some kind of preliminary work always motivates the study period—experiment, demonstration, discussion, development through Socratic questioning, or any other form of approach which the

instructor may choose. The question often arises, "Should your study period precede or follow the recitation?" If the instructor uses supervised study as the means to an end it may take either place, or both. The discussion period may precede the study, or follow it, or the study may be sandwiched between two discussions, one a preview, one a checkup. Problems arising during the presentation of a new unit may demand that the entire time allotted to the subject be given to study for several days. The answer to "When do you have supervised study?" is "What do you want it to accomplish?"

(To Be Continued)

Science in Vegetable Garden

Continued from Page Seven

by chemists since Leibig conceived the idea that the way to determine the fertilizer needs of plants was to analyze the plants in order to know the amounts of soil nutrients contained. Nutrients were then added to the soil in the proportion indicated by the analysis. We know now that this method is not adequate. The response that plants make to a given fertilizer treatment is the most reliable guide for determining fertilizer needs. Many of us do not have time to experiment much with fertilizers in our gardens. In most sections of the country it will pay to use a complete fertilizer, for it is usually safe to assume that adequate fertilization will assure a yield twice as large as would result were no fertilizer or manure used. A 5-10-5 fertilizer used at the rate of about 4 pounds per 100 square feet, applied broadcast and thoroughly worked into the soil after the soil has been plowed, should supply the necessary nutrients.

During seasons of heavy rainfall, longer growing crops such as muskmelons and tomatoes may be benefited by an application of some readily available nitrogen, such as nitrate of soda. I know of no laboratory exercise which is more impressive than the response which a nitrogen-starved plant makes following the application of readily available nitrogen. To see the yellow foliage turn green and the plants again make good growth should satisfy those who are reluctant to experiment in biological fields because they do not always get such cut and dried results as are so easily obtainable in a test tube laboratory.

Pests which are always with us in the vegetable garden often dismay the uninitiated, but to those who view their gardens as a hobby they offer additional problems seeking solution. Fortunately, most of the pests which are common in gardens can be held in check if the control methods worked out by pathologists and entomologists are applied. In practice this means that the gardener will need a small dust-gun costing about one dollar, and three kinds of dust—a rotenone dust for chewing insects—a copper-lime dust for the control of many fungi—and occasionally a nicotine dust for suck-

ing insects such as aphids. There are some pests that do not yield to any of these dusts, but in general a few moments spent in applying these remedies will give results.

Weeds will always be ready to take over the garden in case the operator allows his enthusiasm to wane, but this should not be much of a factor for any one who has learned how to control weeds easily. With a small wheei hoe they can be destroyed in a jiffy if cultivating is done while the weeds are small. A gardener's reputation was once measured by the number of times which he cultivated the soil. Many cultivated at least once a week even during dry weather. Experimental work indicates that such a practice is not necessary. Cultivate enough to control weeds and no more. Excessive cultivation does not conserve soil moisture—it may do harm by destroying some of the plant's roots.

Success in gardening depends largely on following a carefully made plan. Gardening soon becomes a pleasure for those interested in it—for those who like to watch plants respond to a small amount of care intelligently administered.

"Books must follow sciences and not sciences books." —*Bacon.*

A Letter

EDITOR, THE SCIENCE COUNSELOR

Dear Sir:

Reverend Father S. M. Zaborowski, C.S.Sp., of Bydgoszcz, Poland, writes me that Thorn, as it used to be called, is no longer in East Prussia as it was before the war, but now, as Torun, is one of the principal cities of Pomerania in Poland since the Treaty of Versailles.

In my article on Copernicus in the September, 1935, issue of your magazine I had referred to Thorn as being in East Prussia.

It is a thoroughly Polish city, and it and Bydgoszcz, which I may say is pronounced Bid-Goshch, are rival cities for supremacy in Pomerania on the land adjoining the Baltic Sea.

Father Zaborowski is very glad that we should be recognizing the great Polish scientist, Copernicus, over in this country.

Yours very sincerely,

New York City. *James J. Walsh.*

"One science only will one genius fit,
So vast is art, so narrow human wit."
Pope.

TIME WASTERS

Can you defend any of these practices? Are you guilty?

1. Calling roll.

Don't do it. Check by aisles, by seat schedules, or by monitor's reports—never by calling roll.

2. Taking standings.

Calling roll for standings is inexcusable. Wastes valuable minutes each time it is done.

(a) Collect papers, enter standings later yourself.
(b) Collect papers, have student helper record standings.
(c) Have student record standings on a separate sheet, copy later yourself.

3. Oral reading for facts.

Study-classes read *silently* for content. "Read this paragraph to yourself quickly. What is the most important thing? The next?" or "What do you find is the cause of .... ?"

4. Teaching without the attention of every student.

Do not develop new work from textbooks in the hands of students. You cannot determine those students who are paying attention. When developing a new point, use the board. Have every eye centered there. Use the question and answer method.

A teacher who can't work without a book doesn't know his subject.

5. Failure to plan the lesson in detail.

Plan your method of attack *in advance*. Devise an approach that stirs up interest. Arrange your questions in logical order. Put them in your plan book.

Give as little information as possible to the students. Draw from them what you want. *Never tell key facts*. Question until you get them. See that your questions will lead the pupils to correct conclusions.

Study the biology outline printed in another part of this issue. Then see if your own plans cannot be improved.

Analysis of Industrial Gases

Continued from Page Fourteen

known, the analyst must resort to trial until he is sure that he is adding sufficient oxygen.

The oxygen, however, is not mixed with the sample at the outset. The latter is stored in the first pipette and the oxygen then measured in the burette and passed into the slow combustion pipette.

The sample is next returned to the burette, the platinum coil heated to a bright red and the sample passed slowly into the slow combustion pipette where the methane burns as it hits the coil.

After passing the mixture back and forth over the coil several times, it is drawn back into the burette and the volume measured and the amount of contraction recorded.

Then the amount of carbon dioxide produced is determined by absorption in the first pipette as before. Knowing the contraction in volume and the amount of carbon dioxide produced, the amount of methane present is readily calculated.

From the equation:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

we find that methane contracts twice and produces one volume of CO_2. The contraction in volume is the more reliable of the two data. Therefore,

$$\text{Contraction in volume} = 2 \times \text{methane}$$

or

$$\text{ml. of methane} = \frac{\text{contraction in ml.}}{2}$$

$$\text{Per cent of methane} = \frac{\text{ml. methane}}{\text{vol. original sample}} \times 100$$

The calculations for the foregoing analysis are as follows:

Volume of original sample in ml.	= A
Volume after CO_2 absorption	= B
Contraction (A–B)	= C
$\% \ CO_2 = \frac{C}{A} \times 100$	
Volume after oxygen absorption	= D
Contraction (B–D)	= E
$\% \ O_2 = \frac{E}{A} \times 100$	
Volume after CO absorption	= F
Contraction (D–F)	= G
$\% \ CO = \frac{G}{A} \times 100$	
Oxygen added for burning CH_4	= H
Total volume of sample before burning, F + H	= J
Volume after burning	= K
Contraction (J–K)	= L
ml. of methane $= \frac{L}{2}$	= M
$\% \text{ of } CH_4 = \frac{M}{A} \times 100$	
$\% \ N_2 = \frac{A - \text{ml. of other components}}{A} \times 100$	

This covers briefly the fundamental procedure in the analysis of industrial gas mixtures. The technique in routine or control work where accuracy need not be of the highest possible order is comparatively simple. The apparatus becomes more elaborate and increased skill is demanded when complex mixtures and greater accuracy are involved.

The U. S. Bureau of Mines in Pittsburgh, has several large laboratories devoted to the analysis of mine and industrial gases. There is scarcely an industry in the district that is not concerned daily or periodically with gas analysis.

A few books are listed below for the convenience of those who wish to pursue the subject further.

BIBLIOGRAPHY

The Gas Chemists Handbook, Third Edition. American Gas Association, New York.

Methods of the Chemists of the U. S. Steel Corporation for the Sampling and Analysis of Gases. Carnegie-Illinois Steel Company, Pittsburgh, Pa.

Methods of Gas Analysis, L. M. Dennis.

Sampling and Examination of Mine Gases and Natural Gas. Burrell and Seibert, U. S. Bureau of Mines.

D. U. Science Conference

The fourth annual conference for teachers of science in the Catholic high schools of the Pittsburgh district, which was held on the university campus on Saturday, February 29, was attended by some 300 teaching sisters from eight dioceses. They were welcomed by the Most Reverend Hugh C. Boyle, Bishop of Pittsburgh, by the Reverend Paul E. Campbell, Superintendent of Parish Schools, and by the Reverend S. J. Bryan, Acting President of Duquesne University. Dr. Hugh C. Muldoon, director of the conference, presided.

At the general morning session Dr. A. John Goetz, professor of education, discussed Education as a Science. The most recent information concerning Heavy Water was presented by Dr. Roland Schaffert, assistant professor of physics. Miss Mary W. Muldoon, principal of the Junior High School, Waverly, N. Y., gave a practical talk on Teaching Pupils How to Study.

After lunch, demonstrations of experiments in chemistry, biology and physics were given by Professors Matejczyk, Voss and Schaffert. Three round table discussions followed. Sister Florence, S.S.J. of Annunciation High School, Pittsburgh, led the chemistry round table; Sister Marie Therese, D.P., of St. Basil High School, Carrick, was leader of the biology group; and Sister M. Clementine, S.C. of St. Luke High School, Carnegie, conducted the discussion in physics.

A splendid exhibit of student projects in science, loaned by the Catholic high schools, gave evidence of the fine work in science that is being done in the Catholic schools. The Duquesne University prize for the best essay on The Effect of Temperature in the Preservation of Foods was won by Miss Margaret Smith of Lourdes Academy, Cleveland, Ohio. Some 40 high schools competed for this honor.

The Sisters' Alumnae of Duquesne University, who acted as guides and hostesses to the visiting teachers, served tea to the guests during the social hour in the late afternoon.